SCIENCE

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*ASPECTS OF AMERICAN ASTRONOMY.**

THE University of Chicago yesterday accepted one of the most munificent gifts ever made for the promotion of any single science, and with appropriate ceremonies dedicated it to the increase of our knowledge of the heavenly bodies. The President of your University has done me the honor of inviting me to supplement what was said on that occasion by some remarks of a more general nature.

One is naturally disposed to say first what is uppermost in his mind. At the present moment this will naturally be the general impression made by what has been seen and heard. The ceremonies were attended not only by a remarkable delegation of cititizens, but by a number of visiting astronomers, which seems large when we consider that the profession itself is not at all numerous in any country. As one of these, your guests, I am sure that I give expression only to their unanimous sentiment in saying that we have been extremely gratified in many ways by all that we have seen and heard. The mere fact of so munificent a gift to science cannot but excite universal admiration. We knew well enough that it was nothing more than might have been expected from the public spirit of this great West; but the first view

*Address by Professor Simon Newcomb, LL.D., on the occasion of the dedication of the Yerkes Observatory, University of Chicago, October 22, 1897.

of a towering snow peak is none the less impressive because you have learned in your geography how many feet high it is, and great acts are none the less admirable because they correspond to what you have heard and read, and might therefore be led to expect.

The next gratifying feature is the great public interest excited by the occasion. That the opening of a purely scientific institution should have led so large an assemblage of citizens to devote an entire day, including a long journey by rail, to the celebration of yesterday is something most suggestive from its unfamiliarity. A great many scientific establishments have been inaugurated during the last half century, but if on any such occasion so large a body of citizens has gone so great a distance to take part in the inauguration the fact has at the moment escaped from my mind.

That the interest thus shown is not confined to the hundreds of attendants, but must be shared by your great public, is shown by the unfailing barometer of journalism. Here we have a field in which the non-survival of the unfit is the rule in its most ruthless form; the journals that we see and read are merely the fortunate few of a countless number, dead and forgotten, that did not know what the public wanted to read about. The eagerness shown by the representatives of your press in recording everything your guests would say was accomplished by an enterprise in making known everything that occurred, and, in case of an emergency requiring a heroic measure, what did not occur, which shows that smart journalists of the East must have learned their trade, or at least breathed their inspirations in these regions. I think it was some twenty years since I told a European friend that the eighth wonder of the world was a Chicago daily newspaper. Since that time the course of journalistic enterprise has been in the reverse direction, to that of the course of empire eastward, instead of westward.

It has been sometimes said—wrongfully I think—that scientific men form a mutual admiration society. One feature of the occasion made me feel that we, your guests, ought then and there to have organized such a society, and forthwith proceeded to business; this feature consisted in the conferences on almost every branch of astronomy by which the celebration of yesterday was preceded. The fact that beyond the acceptance of a graceful compliment I contributed nothing to these conferences relieves me from the charge of bias or self-assertion in saying that they gave me a new and most inspiring view of the energy now being expended in research by the younger generation of astronomers. All the experience of the past leads us to believe that this energy will reap the reward which Nature always bestows upon those who seek her acquaintance from unselfish motives. In one way it might appear that little was to be learned from a meeting like that of the present week; each astronomer may know by publications pertaining to the science what all the others are doing. But knowledge obtained in this way has a sort of abstractness about it, a little like our knowledge of the progress of civilization in Japan, or of the great extent of the Australian continent. It was, therefore, a most happy thought on the part of your authorities to bring together the largest possible number of visiting astronomers from Europe as well as America, in order that each might see, through the attrition of personal contact, what progress the others were making in their researches. To the visitors, at least, I am sure that the result of this meeting has been extremely gratifying. They earnestly hope, one and all, that the callers of the conference will not themselves be more disappointed in its

results; that, however little they may have actually to learn of methods and results, they will feel stimulated to well-directed efforts and find themselves inspired by thoughts which, however familiar, will now be more easily worked out.

We may pass from the aspects of the case as seen by the more strictly professional class to those more general aspects fitted to excite the attention of the great public. From the point of view of the latter it may well appear that the most striking feature of the celebration is to be found in the great amount of effort which it shows to be devoted to the cultivation of a field quite outside the ordinary range of human interests. A little more than two centuries ago Huyghens prefaced an account of his discoveries on the planet Saturn with the remark that many, even among the learned, might think he had been devoting to things too distant to interest mankind an amount of study which would better have been devoted to subjects of more immediate concern. It must be admitted that this fear has not deterred succeeding astronomers from pursuing their studies. The enthusiastic students whom we see around us are only a detachment from an army of investigators who, in many parts of the world, are seeking to explore the mysteries of creation. Why so great an expenditure of energy? Certainly not to gain wealth, for astronomy is perhaps the one field of scientific work which, in our expressive modern phrase, 'has no money in it.' It is true that the great practical use of astronomical science to the country and the world in affording us the means of determining positions on land and at sea is frequently pointed out. It is said that an Astronomer Royal of England once calculated that every meridan observation of the moon made at Greenwich was worth a pound sterling, on account of the help it would afford to the navigation of the ocean. An accurate map of the United States cannot be constructed without astronomical observations at numerous points scattered over the whole country, aided by data which great observatories have been accumulating for more than a century and must continue to accumulate in the future.

But neither the measurement of the earth, the making of maps, nor the aid of the navigator is the main object which the astronomers of to-day have in view. If they do not quite share the sentiment of that eminent mathematician who is said to have thanked God that his science was one which could not be prostituted to any useful purpose, they still know well that to keep utilitarian objects in view would only prove a handicap on their efforts. Consequently, they never ask in what way their science is going to benefit mankind.

As the great captain of industry is moved by the love of wealth and the politician by the love of power, so the astronomer is moved by the love of knowledge for its own sake, and not for the sake of its application. Yet he is proud to know that his science has been worth more to mankind than it has cost. He does not value its results merely as a means of crossing the ocean or mapping the country, for he feels that man does not live by bread alone. If it is not more than bread to know the place we occupy in the universe it is certainly something which we should place not far behind the means of subsistence. That we now look upon a comet as something very interesting, of which the sight affords us a pleasure unmixed with fear of war, pestilence or other calamity, and of which we therefore wish the return, is a gain that we cannot measure by money. In all ages astronomy has been an index to the civilization of the people who cultivated it. It has been crude or exact, enlightened or mingled with superstition, according to the current mode of thought. When once men understand

the relation of the planet on which they dwell to the universe at large superstition is doomed to speedy extinction. This alone is an object worth more than money.

Astronomy may fairly claim to be that science which transcends all others in its demands upon the practical application of our reasoning powers. Look at the stars that stud the heavens on a clear evening. What more hopeless problem to one confined to earth than that of determining their varying distances, their motions and their physical constitution? Everything on earth we can handle and investigate. But how investigate that which is ever beyond our reach, on which we can never make an experiment? On certain occasions we see the moon pass in front of the sun and hide it from our eyes. To an observer a few miles away the sun was not entirely hidden, for the shadow of the moon in a total eclipse is rarely 100 miles wide. On another continent no eclipse at all may have been visible. Who shall take a map of the world and mark upon it the line on which the moon's shadow will travel during some eclipse a hundred years hence? Who shall map out the orbits of the heavenly bodies as they are going to appear in a hundred thousand years? How shall we ever know of what chemical elements the sun and the stars are made? All this has been done, but not by the intellect of any one man. The road to the stars has been opened only by the efforts of many generations of mathematicians and observers, each of whom began where his predecessor had left off.

We have reached a certain stage where we know much about the heavenly bodies. We have mapped out our solar system with great precision. But how with that great universe of millions of stars in which our solar system is only a speck of star dust, a speck which a traveler through the wilds of space might pass a hundred times without notice? We have learned much about this universe, though our knowledge of it is still dim. We see it as a traveler on a mountain top sees a distant city in a cloud of mist, by a few specks of glimmering light from steeples or roofs. We want to know more about it, its origin and its destiny; its limits in time and space, if it has any; what function it serves in the universal economy. The journey is long, yet we want, in knowledge at least, to reach the stars. Hence we build observatories and train observers and investigators. Slow, indeed, is progress in the solution of the greatest of problems when measured by what we want to know. Some questions may require centuries, others thousands of years for their answer. And yet never was progress more rapid than during our time. In some directions our astronomers of to-day are out of sight of those of fifty years ago; we are even gaining heights which twenty years ago looked hopeless. Never before had the astronomer so much work, good, hard, yet hopeful work, before him as to-day. He who is leaving the stage feels that he has only begun and must leave his successors with more to do than his predecessors left him.

To us an interesting feature of this progress is the part taken in it by our own country. The science of our day, it is true, is of no country. Yet, we very appropriately speak of American science from the fact that our traditional reputation has not been that of a people deeply interested in the higher branches of intellectual work. Men yet living can remember when in the eyes of the universal church of learning all cisatlantic countries, our own included, were *partes infidelium*.

Yet American astronomy is not entirely of our generation. In the middle of the last century Professor Winthrop of Harvard was an industrious observer of eclipses and kindred phenomena, whose work was recorded in the transactions of learned socie-

ties. But the greatest astronomical activity during our colonial period was that called out by the transit of Venus in 1769, which was visible in this country. A committee of the American Philosophical Society at Philadelphia organized an excellent system of observations, which we now know to have been fully as successful, perhaps more so, than the majority of those made on other continents, owing mainly to the advantages of air and climate. Among the observers was the celebrated Rittenhouse, to whom is due the distinction of having been the first American astronomer whose work has an important place in the history of the science. In addition to the observations which he has left us, he was the first inventor or proposer of the collimating telescope, an instrument which has become almost a necessity wherever accurate observations are made. The fact that the subsequent invention by Bessel was quite independent does not detract from the merits of either.

Shortly after the transit of Venus which I have mentioned, the War of the Revolution commenced. The generation which carried on that war, and the following one which formed our Constitution and laid the bases of our political institutions, were naturally too much occupied with these great problems to pay much attention to pure science. When the great mathematical astronomers of Europe were laying the foundation of celestial mechanics their meetings were a sealed book to every one on this side the Atlantic, and so remained till Bowditch appeared, early in the present century. His translation of the *Mécanique Céleste* made an epoch in American science by bringing the great work of Laplace down to the reach of the best American students of his time.

American astronomers must always honor the names of Rittenhouse and Bowditch. And yet, in one respect their work was disappointing of results. Neither of them was the founder of a school. Rittenhouse left no successor to carry on his work. The help which Bowditch afforded his generation was invaluable to isolated students who, here and there, dived alone and unaided into the mysteries of the celestial motions. His work was not mainly in the field of observational astronomy, and therefore did not materially influence that branch of the science. In 1832 Professor Airy, afterward Astronomer Royal of England, made a report to the British Association on the condition of practical astronomy in various countries. In this report he remarked that he was unable to say anything about American astronomy because, so far as he knew, no public observatory existed in the United States.

William C. Bond, afterward famous as the first Director of the Harvard Observatory, was at that time making observations with a small telescope, first near Boston, and afterward at Cambridge. But with so meager an outfit his establishment could scarcely lay claim to being an astronomical observatory, and it was not surprising if Airy did not know anything of his modest efforts.

If at this time Professor Airy had extended his investigations into yet another field, with a view of determining the prospects for a great city at the cite of Fort Dearborn, on the southern shore of Lake Michigan, he would have seen as little prospect of civic growth in that region as of a great development of astronomy in the United States at large. A plat of the proposed town of Chicago had been prepared two years before, when the place contained perhaps half a dozen families. In the same month in which Professor Airy made his report, August, 1832, the people of that place, then numbering twenty-eight voters, decided to become incorporated, and selected five trustees to carry on their government.

In 1837 a city charter was obtained from

the Legislature of Illinois. The growth of this infant city, then small even for an infant, into the great commercial metropolis of the West has been the just pride of its people and the wonder of the world. I mention it now because of a remarkable coincidence. With this civic growth has quietly gone on another, little noted by the great world, and yet in its way equally wonderful and equally gratifying to the pride of those who measure greatness by intellectual progress. If it be true that "in nature nothing is great but man, in man nothing is great but mind," then may knowledge of the universe be regarded as the true measure of progress. I, therefore, invite attention to the fact that American astronomy began with your city, and has slowly but surely kept pace with it until to-day our country stands second only to Germany in the number of researches being prosecuted, and second to none in the number of men who have gained the highest recognition by their labors.

In 1836 Professor Albert Hopkins, of Williams College, and Professor Elias Loomis, of Western Reserve College, Ohio, both commenced little observatories. Professor Loomis went to Europe for all his instruments, but Hopkins was able even then to get some of his in this country. Shortly afterward a little wooden structure was erected by Captain Gilliss on Capitol Hill, at Washington, and supplied with a transit instrument for observing moon culminations in conjunction with Captain Wilkes, who was then setting out on his exploring expedition to the southern hemisphere. The date of these observatories was practically the same as that on which a charter for the City of Chicago was obtained from the Legislature. With their establishment the population of your city had increased to 703.

The next decade, 1840 to 1850, was that in which our practical astronomy seriously commenced. The little observatory of Captain Gilliss was replaced by the Naval Observatory, erected at Washington during the years 1843–4 and fitted out with what were then the most approved instruments. About the same time the appearance of the great comet of 1843 led the citizens of Boston to erect the observatory of Harvard College. Thus it is little more than half a century since the two principal observatories in the United States were established. But we must not for a moment suppose that the mere erection of an observatory can mark an epoch in scientific history. What must have made the decade of which I speak ever memorable in American astronomy was not merely the erection of buildings, but the character of the work done by astronomers away from them as well as in them.

The Naval Observatory very soon became famous by two remarkable steps which raised our country to an important position among those applying modern science to practical uses. One of these consisted of the researches of Sears Cook Walker on the motion of the newly-discovered planet Neptune. He was the first astronomer to determine fairly good elements of the orbit of that planet, and, what is yet more remarkable, he was able to trace back the movement of the planet in the heavens for half a century and to show that it had been observed as a fixed star by Lalande in 1795 without the observer having any suspicion of the true character of the object.

The other work to which I refer was the application to astronomy and to the determination of longitudes of the chronographic method of registering transits of stars or other phenomena requiring an exact record of the instant of their occurrence. It is to be regretted that the history of this application has not been fully written. In some points there seems to be as much obscurity as with the discovery of ether as an an-

æsthetic, which took place about the same time. Happily, no such contest has been fought over the astronomical as over the surgical discovery, the fact being that all who are engaged in the application of the new method were more anxious to perfect it than they were to get credit for themselves. We know that Saxton, of the Coast Survey; Michell and Locke, of Cincinnati; Bond at Cambridge, as well as Walker and other astronomers at the Naval Observatory, all worked at the apparatus; that Maury seconded their efforts with untiring zeal, that it was used to determine the longitude of Baltimore as early as 1844 by Captain Wilkes, and that it was put into practical use in recording observations at the Naval Observatory as early as 1846.

At the Cambridge Observatory the two Bonds, father and son, speedily began to show the stuff of which the astronomer is made. A well devised system of observations was put in operation. The discovery of the dark ring of Saturn and of a new satellite to that planet gave additional fame to the establishment.

Nor was activity confined to the observational side of the science. The same decade of which I speak was marked by the beginning of Professor Pierce's mathematical work, especially his determination of the perturbations of Uranus and Neptune. At this time commenced the work of Dr. B. A. Gould, who soon became the leading figure in American astronomy. Immediately on graduating at Harvard, in 1845, he determined to devote all the energies of his life to the prosecution of his favorite science. He studied in Europe for three years, took the doctor's degree at Göttingen, came home, founded the *Astronomical Journal*, and took an active part in that branch of the work of the Coast Survey which included the determination of longitudes by astronomical methods.

An episode which may not belong to the history of astronomy must be acknowledged to have had a powerful influence in exciting public interest in that science. Professor O. M. Mitchel, the founder and first Director of the Cincinnati Observatory, made the masses of our intelligent people acquainted with the leading facts of astronomy by courses of lectures which, in lucidity and eloquence, have never been excelled. The immediate object of the lectures was to raise funds for establishing his observatory and fitting it out with a fine telescope. The popular interest thus excited in the science had an important effect in leading the public to support astronomical research. If public support, based on public interest, is what has made the present fabric of American astronomy possible, then should we honor the name of a man whose enthusiasm leavened the masses of his countrymen with interest in our science.

The Civil War naturally exerted a depressing influence upon our scientific activity. The cultivator of knowledge is no less patriotic than his fellow citizens, and vies with them in devotion to the public welfare. The active interest which such cultivators took, first in the prosecution of the war and then in the restoration of the Union, naturally distracted their attention from their favorite pursuits. But no sooner was political stability reached than a wave of intellectual activity set in, which has gone on increasing up to the present time. If it be true that never before in our history has so much attention been given to education as now; that never before did so many men devote themselves to the diffusion of knowledge, it is no less true that never was astronomical work so energetically pursued among us as now. One deplorable result of the Civil War was that Gould's *Astronomical Journal* had to be suspended. Shortly after the restoration of peace, instead of re-establishing the journal, its founder conceived the project of exploring

the southern heavens. The northern hemisphere being the seat of civilization, that portion of the sky which could not be seen from our latitudes was comparatively neglected. What had been done in the southern hemisphere was mostly the occasional work of individuals and of one or two permanent observatories. The latter were so few in number and so meager in their outfit that a splendid field was open to the inquirer. Gould found the patron which he desired in the government of the Argentine Republic, on whose territory he erected what must rank in the future as one of the memorable astronomical establishments of the world. His work affords a most striking example of the principle that the astronomer is more important than his instruments. Not only were the means at the command of the Argentine observatory slender in the extreme when compared with those of the favored institutions of the north, but, from the very nature of the case, the Argentine Republic could not supply trained astronomers. The difficulties thus growing out of the administration cannot be overestimated. And yet the sixteen great volumes in which the work of the institution has been published will rank in the future among the classics of astronomy.

Another wonderful focus of activity, in which one hardly knows whether he ought most to admire the exhaustless energy or the admirable ingenuity which he finds displayed, is the Harvard Observatory. Its work has been aided by gifts which have no parallel in the liberality that prompted them. Yet without energy and skill such gifts would have been useless. The activity of the establishment includes both hemispheres. Time would fail to tell how it has not only mapped out important regions of the heavens from the north to the south pole, but analyzed the rays of light which come from hundreds of thousands of stars by recording their spectra in permanence on photographic plates. The work of the establishment is so organized that a new star cannot appear in any part of the heavens, nor a known star undergo any noteworthy change, without immediate detection by the photographic eye of one or more little telescopes, all seeing and never sleeping policemen, that scan the heavens unceasingly while the astronomer may sleep, and report in the morning every case of irregularity in the proceedings of the heavenly bodies.

Yet another example showing what great results may be obtained with limited means is afforded by the Lick Observatory, of California. During the ten years of its activity its astronomers have made it known the world over by its unequaled works and discoveries, too varied and numerous to be even mentioned at the moment.

The astronomical work of which I have thus far spoken has been almost entirely that done at observatories. I fear that I may in this way have strengthened an erroneous impression that the seat of important astronomical work is necessarily connected with an observatory. It must be admitted that an institution which has a local habitation and a magnificent building commands public attention so strongly that valuable work done elsewhere may be overlooked. A very important part of astronomical work is done away from telescopes and meridian circles, and requires nothing but a good library for its prosecution. One who is devoted to this side of the subject may often feel that the public does not appreciate his work at its true relative value, from the very fact that he has no great buildings or fine instruments to show. I may, therefore, be allowed to claim as an important factor in the American astronomy of the last half century an institution of which few have heard and which has been overlooked because there was nothing about it to excite attention.

In 1849 the *American Nautical Almanac* office was established by a Congressional appropriation. The title of this publication is somewhat misleading in suggesting a simple enlargement of the family almanac which the sailor is to hang up in his cabin for daily use. The fact is that what started more than a century ago as a nautical almanac has since grown into an astronomical ephemeris for the publication of everything pertaining to times, seasons, eclipses and the motions of the heavenly bodies. It is the work in which astronomical observations made in all the great observatories of the world are ultimately utilized for scientific and public purposes. Each of the leading nations of western Europe issues such a publication. When the preparation and publication of the *American Ephemeris* was decided upon the office was first established in Cambridge, the seat of Harvard University, because there could most readily be secured the technical knowledge of mathematics and theoretical astronomy necessary for the work.

A field of activity was thus opened, of which a number of able young men who have since earned distinction in various walks of life availed themselves. The head of the office, Commander Davis, adopted a policy well fitted to promote their development. He translated the classic work of Gauss, *Theovia Motus Corporum Cœlestium*, and made the office a sort of informal school, not, indeed, of the modern type, but rather more like the classic grove of Hellas, where philosophers conducted their discussions and profited by mutual attrition. When, after a few years of experience, methods were well established and a routine adopted, the office was removed to Washington, where it has since remained. The work of preparing the ephemeris has, with experience, been reduced to a matter of routine which may be continued indefinitely with occasional changes in methods and data and improvements to meet the increasing wants of investigators.

The mere preparation of the ephemeris includes but a small part of the work of mathematical calculation and investigation required in astronomy. One of the great wants of the science to-day is the re-reduction of the observations made during the first half of the present century, and even during the last half of the preceding one. The labor which could profitably be devoted to this work would be more than that required in any one astronomical observatory. It is unfortunate for this work that a great building is not required for its prosecution, because its needfulness is thus very generally overlooked by that portion of the public interested in the progress of science. An organization especially devoted to it is one of the scientific needs of our time.

In such an epoch-making age as the present it is dangerous to cite any one step as making a new epoch. Yet it may be that when the historian of the future reviews the science of our day he will find the most remarkable feature of the astronomy of the last twenty years of our century to be the discovery that this steadfast earth of which the poets have told us is not after all quite steadfast; that the north and south poles move about a very little, describing curves so complicated that they have not yet been fully marked out. The periodic variations of latitude thus brought about were first suspected about 1880, and announced with some modest assurance by Küstner, of Berlin, a few years later. The progress of astronomical opinion from incredulity to confidence, was extremely slow until, about 1890, Chandler, of the United States, by an exhaustive discussion of innumerable results of observations, showed that the latitude of every point on the earth was subject to a double oscillation, one having the period of a year, the other of 427 days

Notwithstanding the remarkable parallel between the growth of American astronomy and that of your city, one cannot but fear that if a foreign observer had been asked only half a dozen years ago at what point in the United States a great school of theoretical and practical astronomy, aided by an establishment for the exploration of the heavens, was likely to be established by the munificence of private citizens, he would have been wiser than most foreigners had he guessed Chicago. Had this place been suggested to him I fear he would have replied that were it possible to utilize celestial knowledge in acquiring earthly wealth here would be the most promising seat for such a school. But he would need to have been a little wiser than his generation to reflect that wealth is at the base of all progress in knowledge and the liberal arts; that it is only when men are relieved from the necessity of devoting all their energies to the immediate wants of life that they can lead intellectual lives, and that we should therefore look to the most enterprising commercial center as the likeliest seat for a great scientific institution.

Now we have the school, and we have the observatory, which we hope will in the near future do work that will cast luster on the name of its founder as well as on the astronomers who may be associated with it. You will, I am sure, pardon me if I make some suggestions on the subject of the future needs of the establishment. We want this newly founded institution to be a great success, to do work which shall show that the intellectual productiveness of your community will not be allowed to lag behind its material growth. The public is very apt to feel that when some munificent patron of science has mounted a great telescope under a suitable dome and supplied all the apparatus which the astronomer wants to use success is assured. But such is not the case. The most important requisite, one more difficult to command than telescopes or observatories, may still be wanting. A great telescope is of no use without a man at the end of it, and what the telescope may do depends more upon this appendage than upon the instrument itself. The place which telescopes and observatories have taken in astronomical history are by no means proportional to their dimensions. Many a great instrument has been a mere toy in the hands of its owner. Many a small one has become famous. Twenty years ago there was here in your own city a modest little instrument which, judged by its size, could not hold up its head with the great ones even of that day. It was the private property of a young man holding no scientific position and scarcely known to the public. And yet that little telescope is to-day among the famous ones of the world, having made memorable advances in the astronomy of double stars and shown its owner to be a worthy successor of the Herschels and the Struves in that line of work.

A hundred observers might have used the appliances of the Lick Observatory for a whole generation without finding the fifth satellite of Jupiter; without successfully photographing the cloud forms of the Milky Way; without discovering the extraordinary patches of nebulous light, nearly or quite invisible to the human eye, which fill some regions of the heavens.

When I was in Zurich last year I paid a visit to the little but not unknown observatory of its famous polytechnic school. The professor of astronomy was especially interested in the observations of the sun with the aid of the spectroscope, and among the ingenious devices which he described, not the least interesting was the method of photographing the sun by special rays of the spectrum which had been worked out at the Kenwood Observatory in Chicago. The Kenwood Observatory is not, I believe, in the eye of the public one of the

noteworthy institutions of your city which every visitor is taken to see, and yet this invention has given it an important place in the science of our day.

Should you ask me what are the most hopeful features in the great establishment which you are now dedicating, I would say that they are not alone to be found in the size of your unequaled telescope, nor in the cost of the outfit, but in the fact that your authorities have shown their appreciation of the requirements of success by adding to the material outfit of the establishment the three men whose works I have described.

Gentlemen of the Trustees, allow me to commend to your fostering care the men at the end of the telescope. The constitution of the astronomer shows curious and interesting features. If he is destined to advance the science by works of real genius he must, like the poet, be born, not made. The born astronomer, when placed in command of a telescope, goes about using it as naturally and effectively as the babe avails itself of its mother's breast. He sees intuitively what less-gifted men have to learn by long study and tedious experiment. He is moved to celestial knowledge by a passion which dominates his nature. He can no more avoid doing astronomical work, whether in the line of observations or research, than the poet can chain his Pegasus to earth. I do not mean by this that education and training will be of no use to him. They will certainly accelerate his early progress. If he is to become great on the mathematical side, not only must his genius have a bent in that direction, but he must have the means of pursuing his studies. And yet I have seen so many failures of men who had the best instruction, and so many successes of men who scarcely learned anything of their teachers, that I sometimes ask whether the great American celestial mechanician of the twentieth century will be a graduate of a university or of the backwoods.

Is the man thus moved to the exploration of nature by an unconquerable passion more to be envied or pitied? In no other pursuit does success come with such certainty to him who deserves it. No life is so enjoyable as that whose energies are devoted to following out the inborn impulses of one's nature. The investigator of truth is little subject to the disappointments which await the ambitious man in other fields of activity. It is pleasant to be one of a brotherhood extending over the world in which no rivalry exists except that which comes out of trying to do better work than anyone else, while mutual admiration stifles jealousy. And yet, with all these advantages, the experience of the astronomer may have its dark side. As he sees his field widening faster than he can advance he is impressed with the littleness of all that can be done in one short life. He feels the same want of successors to pursue his work that the founder of a dynasty may feel for heirs to occupy his throne. He has no desire to figure in history as a Napoleon of science whose conquests must terminate with his life. Even during his active career his work may be of such a kind as to require the cooperation of others and the active support of the public. If he is disappointed in commanding these requirements, if he finds neither cooperation nor support, if some great scheme to which he may have devoted much of his life thus proves to be only a castle in the air, he may feel that nature has dealt hardly with him in not endowing him with passions like to those of other men.

In treating a theme of perennial interest one naturally tries to fancy what the future may have in store. If the traveler contemplating the ruins of some ancient city which in the long ago teemed with the life and activities of generations of men sees

every stone instinct with emotion and the dust alive with memories of the past, may he not be similarly impressed when he feels that he is looking around upon a seat of future empire, a region where generations yet unborn may take a leading part in moulding the history of the world? What may we not expect of that energy which in sixty years has transformed a straggling village into one of the world's great centers of commerce? May it not exercise a powerful influence on the destiny not only of the country, but of the world? If so, shall the power thus to be exercised prove an agent of beneficence, diffusing light and life among nations, or shall it be the opposite? The time must come ere long when wealth shall outgrow the field in which it can be profitably employed. In what direction shall its possessors then look? Shall they train a posterity which will so use its power as to make the world better that it has lived in it? Will the future heir to great wealth prefer the intellectual life to the life of pleasure?

We can have no more hopeful answer to these questions than the establishment of this great university in the very focus of the commercial activity of the West. Its connection with the institution we have been dedicating suggests some thoughts on science as a factor in that scheme of education best adapted to make the power of a wealthy community a benefit to the race at large. When we see what a factor science has been in our present civilization, how it has transformed the world and increased the means of human enjoyment by enabling men to apply the powers of nature to their own uses, it is not wonderful that it should claim the place in education hitherto held by classical studies. In the contest which has thus arisen I take no part but that of a peacemaker, holding that it is as important to us to keep in touch with the traditions of our race and to cherish the thoughts which have come down to us through the centuries as it is to enjoy and utilize what the present has to offer us. Speaking from this point of view, I would point out the error of making the utilitarian applications of knowledge the main object in its pursuit. It is a historic fact that abstract science, science pursued without any utilitarian end, has been at the basis of our progress in the application of knowledge. If in the last century such men as Galvani and Volta had been moved by any other motive than love of penetrating the secrets of nature they would never have pursued the seemingly useless experiments they did, and the foundations of electrical science would not have been laid. Our present applications of electricity did not become possible until Ohm's mathematical laws of the electric current, which when first made known seemed little more than mathematical curiosities, had become the common property of inventors. Professional pride on the part of our own Henry led him, after making the discoveries which rendered the telegraph possible, to go no further in their application of his discoveries, and to live and die without receiving a dollar of the millions which the country has won through his agency.

In the spirit of scientific progress thus shown we have patriotism in its highest form—a sentiment which does not seek to benefit the country at the expense of the world, but to benefit the world by means of one's country. Science has its competition, as keen as that which is the life of commerce. But its rivalries are over the question who shall contribute the most and the best to the sum-total of knowledge—who shall give the most, not who shall take the most. Its animating spirit is love of truth. Its pride is to do the greatest good to the greatest number. It embraces not only the whole human race, but all nature in its scope. The public spirit of which this city is the focus has made the desert blossom as

the rose, and benefited humanity by the diffusion of the material products of the earth. Should you ask me how it is in the future to use its influence for the benefit of humanity at large, I would say, look at the work now going on in these precincts, and study its spirit. Here are the agencies which will make 'the voice of law the harmony of the world.' Here is the love of country blended with the love of the race. Here the love of knowledge is as unconfined as your commercial enterprise. Let not your youth come hither merely to learn the forms of vertebrates and the properties of oxides, but rather to imbibe that Catholic spirit which, animating their ever-growing energies, shall make their power an agent of beneficence to all mankind.

S. Newcomb.

Washington, D. C.

THE YERKES OBSERVATORY.

The opening of the Yerkes Observatory has been an important event in the progress of science. The last masterpiece of Alvan G. Clark, the forty-inch refractor, has been appropriately established. A great institution for all branches of research in the related fields of astronomy and astrophysics has begun its activity. The University of Chicago has made an important addition to its already large equipment for the discovery and teaching of scientific truth.

A series of conferences, attended by a representative gathering of some sixty of the astronomers and astrophysicists of the country, occupied the three days preceding the formal exercises of dedication on October 21st and 22d. The program, as printed in the recent number of this Journal (No. 147, October 22d) was carried out with but minor changes.

Stimulating discussions followed the presentation of many of the papers, in which a delightful feature was the participation of Professor Carl Runge, of Hannover. Unfortunately, a necessary postponement of the date of the exercises had made it impossible for Professor Schuster, of Manchester, Eng., and M. Deslandres, of Paris, to remain for the conferences.

The demonstrations, in the various laboratories of the Observatory, of new and interesting phenomena formed an important part of the program. The weather was not sufficiently favorable to permit the exhibition, with the great telescope, of many of the celestial objects as planned, but all present on the first two days had the opportunity of testing the light-grasp of the instrument on double stars and nebulæ, and in connection with the solar spectroscope.

The generous hospitality of the University provided for its scientific guests during the week unique entertainment in the spacious rooms of the Observatory itself, and the arrangements for this rather serious undertaking were admirably carried out, with the effective cooperation of a well-known Chicago caterer. To the full extent of their capacity the homes of the resident astronomers were also thrown open to their friends.

The location of the Observatory, selected after long deliberation and full examination of the available situations, commends itself at once, aside from its natural beauty, by reason of its isolation from traffic and manufacturing, a favorable condition which is likely to continue into an indefinite future. The center of motion of the great refractor is about 80 meters above the level of Lake Geneva, which is about 600 meters distant, the elevation above sea-level being about 400 meters. The railway station and post office are over a kilometer distant, at Williams Bay, Wisconsin, on the Chicago and Northwestern Railway, at a distance of 120 kilometers, or two and one-half hours, from Chicago.

The Observatory building, of brown Ro-

man brick, with terra cotta trimmings, is in the form of a Latin cross, having a longer axis of one hundred meters, with the great tower and dome at its western end, and with two smaller (ten-meter) domes at the northern and southern extremities of the shorter axis. A meridian room, with double sheet-iron walls, is at the eastern end of the building. The space of thirty-two meters in the attic between the small towers serves as a heliostat room. The main floor of the building contains offices, computing rooms, spectroscopic laboratories, an instrument and a photographic room, a chemical laboratory, a lecture room, library and reception room. The lower story, or basement, contains a concave grating room, an emulsion, an enlarging and a photographic dark room, and a constant temperature room. Very important features of this floor are the optical and the instrument shops, well supplied with machines and tools. Here large instruments are being constructed, and a sixty-inch glass reflector is now being ground by the optician.

The great dome, twenty-seven meters in diameter and eighteen meters in height, is provided with a rising floor having a vertical range of seven meters and operated by electric motors. This floor is a very essential feature in working with a telescope of sixty-two feet focal length and successfully overcomes what would otherwise be almost insurmountable (acrobatic) difficulties in observing. The massive iron and steel mounting of the forty-inch telescope (constructed, as were the dome and rising floor, by Warner and Swazey), is operated by electric motors regulated at the eye-end. The driving clock controls the motion of a mass of twenty tons.

The tests of the optical efficiency of the telescope have been thoroughly satisfactory. It has also been already demonstrated that the 'seeing' by day is excellent at Williams Bay, a fortunate condition in view of the disturbed day atmosphere at the Lick Observatory, but it is not to be expected that the night seeing can equal that at Mt. Hamilton.

The northeastern dome, nine meters in diameter, shelters the telescope formerly at the Kenwood Observatory, having two 12-inch objectives, visual and photographic. The southeast tower will for the present be occupied by a reflecting telescope. The equipment of the Yerkes Observatory in solar and stellar spectroscopes, gratings and kindred apparatus is already large. The gifts of Mr. Yerkes have included: For the objective, $66,000; for the equatorial mounting, $55,000; for the dome and rising floor, $45,000; for the building and smaller domes, stellar spectrograph, steam heating plant and power house, engine, dynamo and motors, over $145,000. The fifty-five acres of land, valued at $50,000, was given by Mr. John Johnston, Jr.; the instruments of the Kenwood Observatory by Mr. W. E. Hale; and $7,000 for a 10-inch photographic telescope, with building and dome, by Miss Catherine Bruce, of New York, to whose liberality astronomy owes much.

The address at the formal exercises of dedication was delivered in the ninety-foot dome, before a company of six hundred of the officers and guests of the University, by Professor J. E. Keeler on 'The Importance of Astrophysical research and the relation of Astrophysics to other physical sciences.' In a few well chosen words Mr. Charles T. Yerkes presented the deed of the institution to the President of the Trustees of the University, who responded in their behalf, as did President Harper for the Faculty. After a luncheon and inspection of the Observatory a special train conveyed the visitors to Chicago.

On the following day, October 22d, striking demonstrations were given, at the Ryerson Physical Laboratory by Professors Michel-

son and Stratton, of the applications of the interference refractometer and of the effect of a magnet upon radiation recently discovered by Zeeman. Professor Michelson also exhibited a harmonic analyzer, which may, perhaps, find application to certain pending problems of astronomy. The visiting scientists were entertained at luncheon by the President of the University and Mrs. Harper, and at 3 p. m. an address on 'Aspects of American Astronomy' was delivered by Professor Simon Newcomb. Finally the liberal hospitality of Mr. Yerkes provided a banquet in the evening for the visiting scientists.

The work of the Yerkes Observatory has thus been formally inaugurated. The aims of the institution as expressed by the President cannot fail to meet the approval of all friends of science:

"It is proper that a word should be said on behalf of the Faculty with respect to the policy which shall control the University in the use it shall make of the Observatory. The founder has indicated his desire in definite form that the Observatory shall not be used for popular purposes. Situated as it is, in close proximity to a village of large size, and within a short distance of so great a city as Chicago, it would be comparatively easy for the astronomers to occupy their entire time in exhibiting the instruments to the public. For the present it is the desire of the donor and the decision of the Trustees that the Observatory shall not be open to the public.

"In every department of science there is opportunity to-day for the development of what might be called the sensational. In no subject is this possibility greater than in that of astronomy. The work of not a few observatories and of not a few astronomers has been seriously injured by the desire to do and say that which will attract public attention. The Yerkes Observatory will strenuously oppose every tendency of this character, and will make every effort to represent only that kind of work which is of solid and substantial character.

"So much for the negative side. As to the positive policy of the Observatory, I quote from a statement of the Director: 'The policy of the Yerkes Observatory will be: (1) To derive the greatest possible return from the use of the large telescope it is evident that special attention should be given to (*a*) micrometrical observations of stars, satellites, comets, nebulæ, etc.; (*b*) solar investigations, both visual and photographic; and (*c*) spectroscopic researches on the chemical composition of the stars and their motion toward or from the earth. The present staff is sufficient to permit much of this work to be taken up to advantage. Another astronomer will be needed to develop the spectroscopic work, which is, probably, the most important work the Observatory can undertake, on account of its great light-gathering power.

"'(2) To provide for the investigation of any phase of an astronomical or related physical problem. Most American observatories are unprovided with the instruments and laboratories necessary for the interpretation of the phenomena constantly encountered in spectroscopic observations of the heavenly bodies. Spectroscopic laboratories, on the other hand, are not equipped to carry their investigations beyond the artificial boundaries of physics into the realm of astronomy. It is hoped that the Yerkes Observatory may ultimately be in a position to represent both the astronomical and the physical sides of astrophysical work, and at the same time provide the best facilities for research work in astronomy of position.'"

The present staff of the Observatory consists of Professor George E. Hale, Director; Professors S. W. Burnham, E. E. Barnard, F. L. O. Wadsworth; Mr. F. Ellerman, Assistant; Mr. G. W. Ritchey, Optician.

It would appear an urgent need that adequate endowment should be supplied for the maintenance of this splendid institution at the high degree of efficiency of which it is so capable.

EDWIN B. FROST.

THE ALUMNI BIOLOGICAL EXPEDITION OF NEW YORK UNIVERSITY TO THE BERMUDAS.

THE archipelago of the Bermudas was chosen as the ground for the first expedition of the Biological Department of the University for several reasons, among them the following: the means of communication, by the steamships of the Quebec S. S. Co., was easy; they seemed to afford a tropical marine fauna in abundance for study; they were free from the malarious diseases of the West Indies, the fatality of which was so sadly proved this summer in the expedition to Jamaica, and it seemed worth while to investigate the conditions under which a station might be established for permanent research.

Thanks to a number of alumni who made liberal contributions to the enterprise, the party left New York for Hamilton on June 3d. The party consisted of Dr. C. L. Bristol, in charge; Mr. Warren H. Everett, instructor, and Messrs. Brush, Carpenter, Brown, Rosenthal and Grose, of the University; Dr. Walter M. Rankin, of Princeton University, and Dr. Tarleton H. Bean, late of the U. S. Fish Commission and now Director of the Aquarium in New York City. The party was joined later by Mr. Ernest Haycock, of Harvard University. The last of the party arrived in New York on August 8th. Headquarters were established at the Harrington House, about six miles from Hamilton and situated on the narrow strip of land separating Harrington Sound from Castle Harbor. A vacant house near the shore of Castle Harbor was transformed into a comfortable laboratory, and from this as a center trips were made in various directions.

The most attention was given to a search for the various forms and a careful survey of the general conditions subtending their abundance and collection, so that, taken as a whole, the work might prove a reconnaissance and furnish knowledge for future investigations. In this the expedition was fairly successful and would have been much more so but for a long spell of southwest wind which prevented off-shore work, excepting for a few days. One instance of this may be given. Captain Meyers, of St. Georges, very kindly put his large ocean-going tug and a diver at our disposal to go to North Rock, and for a whole week we waited before a favorable morning came, but on that day, just as we arrived at the collecting ground, a heavy wind prevented any serious work. Our work was confined mainly to the lee shores and here we were greatly rewarded. Of corals the genera *Diploria*, *Meandrina*, *Astrea*, *Siderastrea*, *Porites*, *Isophyllia*, *Oculina* and *Mycedium* were found; of gorgonians, *Rhipidogorgia* and *Gorgonia*. The Actinaria are very abundant and our collections are numerous. We found but few hydroids and a millespore coral. The Medusæ and Hydro-Medusæ are very abundant in the still waters of Harrington Sound. The Echinoderms are exceedingly interesting and abundant. The Holothuria are represented by the genera *Holothuria*, *Semperia*, *Stichopus*, the last being very abundant. The Asteroidea are few and are represented by one species of *Asterias* and one of a new genus not yet determined; the Ophiuroidea by several genera. The Echinoidea are represented by *Cidaris*, *Diadema*, *Hipponœ*, *Echinometra*, *Toxopneustes*, *Mellita* and one new genus. The Crustacea are numerous and exceedingly interesting. Our collections will be studied by Dr. Rankin, who will report on them later.

The Mollusca of the archipelago number, according to Heilprin, about 170 marine forms and 30 terrestrial. Among the cephalopoda are *Octopus* and *Argonauta*. The naked *Aplysia* is fairly abundant, and, numerous other naked mollusks are found in Harrington Sound.

The Annelids are not as numerous in the places we searched as we expected, but those we found are new to us and the genera are not yet determined. The sponges are very numerous in genera and plenty in individuals. The Tunicates are exceedingly numerous and offer a rich field for investigations. *Amphioxus* is reported, but we had no opportunity to search for it. The abundance and beauty of the Bermuda fishes is notorious. Dr. Bean is making a study of them, carrying on the work started by his colleague, the late G. Brown Goode. Incidental to the main work of the expedition we undertook to furnish the Aquarium in New York with live specimens of some of these fishes, and thousands of visitors to that institution testify to their beauty and gracefulness. This part of the work was by no means the least interesting. We installed four large tanks and a pumping engine on White's Island, in the harbor of Hamilton, and acclimated the fish before transferring them to the steamship. On board the boat the fish were supplied with running water, thanks to the kindness of the Quebec Steamship Company, and no small part of our success was due to the generous and skillful aid given us by the Chief Engineer, Mr. Ritchie. Under these favorable conditions our loss was slight and another season will be much less. It is interesting to note that our efforts to bring invertebrates alive failed in every case but one, though we could keep them in prime condition until we struck the polluted waters of the coast, when they died quickly. Our failures, however, have suggested remedies, and next year we hope to show *Octopus*, *Palinurus*, *Ibacus*, *Aplysia* and the sea-anemones, as well as the fishes. The fishes thrive in the Aquarium, although the water is several degrees cooler than they are accustomed to and the salinity much less. There would be little difficulty apparently in carrying them from New York across the Atlantic, if that were desirable, under the same conditions that we carried them from Bermuda.

Our hasty survey strengthens the idea of establishing a station, and we are planning to have one in working condition by the summer of 1899, if not before. It will have two stories, the lower given up to aquaria, as at Naples, and open to the public during the winter at a small fee; the upper story will be fitted up for a laboratory, and while under the charge of the University will be open to any one competent to carry on an investigation in botany or zoology. It is not intended to rival any of the stations on the Atlantic coast, but to supplement them and to afford opportunity to investigators of America and Europe to study the flora and fauna of a tropical horizon with ease and comfort. The healthfulness of the place is attested to by the yearly visitation of over two thousand guests who spend the winter months there. Malaria is unknown, as is also prostration by heat. The climate during June and July is not disagreeable, the thermometer rarely going up beyond 82° F.

Another project in hand with the station at the Bermudas is the exploration of the West Indies with the Bermudas as a base. Two lines of steamers connect the islands with the West Indies, and the scientist starting on them equipped from the appliances of the station may make a rapid collecting trip to a desired location and return to work over his material under the more favorable conditions at the station.

Charles L. Bristol.

New York University.

NEW DIAMOND FIND IN THE TRANSVAAL.

THE latest Johannesburg papers (*Standard and Diggers' News, Financial Record*) bring news of a very interesting and probably economically important discovery of diamonds in place, at a distance of no less than 300 miles from the mines of Kimberley and Jagersfontein. The locality is 20 miles east of Pretoria, the capital of the South African Republic, and one mile east of Merwe, a station on the railway leading to Delagoa Bay. The outcrop forms a knoll, or 'kopje,' in the Magaliesburg range. It is on the farm Rietfontein, No. 501. The first announcement of the discovery was made to the Johannesburg Geological Society by Dr. David Draper, on September 12th.

The diamonds are found in a matrix, called by Mr. G. A. F. Molengraaff, State Geologist of the Transvaal, serpentine breccia, similar in nature to kimberlite. This rock extends over a small area not yet fully explored, but known to be at least 160 feet by 250 feet, and believed to be a volcanic neck. The kimberlite is much less decomposed than at Kimberley, the yellow ground being only 5 feet in depth, and the blue ground projecting above the general level, while at Kimberley the yellow or oxidized zone extended to more than 100 feet below the surface.

Only ten 'loads' (of 16 cubic feet) of rock had been washed up to September 20th. These, however, had yielded 23 stones. Dr. Draper reports one stone of 16 carats, another of 23, and the rest smaller. The 16-carat stone is said in the *News*, of September 25th, to be a fragment broken from a larger stone, the remainder of which has not been found. The yield per load would seem to be very high, but the amount washed is too small to justify predictions, while it certainly indicates a good 'prospect.' Dr. Draper reports garnet, carbonado, olivine and 'other minerals associated with the diamond' as present in abundance. He very properly points out the likelihood that there are other diamond deposits in the neighborhood, and suggests the expediency of a search for them.

The new diamond deposit occurs in the quartzites of the Magaliesburg range, about 35 miles due north of the Main Reef Series of the Witwatersrand, at its farthest known eastern extension. The correlation of these quartzites and those along the Witwatersrand is not altogether certain. Some authorities have maintained that the Magaliesburg rocks are equivalent to the series underlying the Main Reef. Others, with better reason, as it seems to me, consider them equivalent to the Gatsrand Series which overlies the Black Reef, to the southward of the Witwatersrand. In either case they are Paleozoic, and much earlier than the coal measures of the Karoo, which are supposed to be Triassic, and which rest unconformably on the Black Reef Series. The rocks of these earlier formations contain no coal and no bituminous shales so far as is known. In this new diamond occurrence there is no apparent reason to attribute the formation of the crystals to the local effect of lava on superficial deposits of amorphous carbon. It will be interesting to ascertain whether the lava of the new locality contains a soluble hydrocarbon like that which Sir Henry Roscoe found in kimberlite.

Diamonds have not been found in the Transvaal in the original matrix until the discovery here reported. In 1893, however, diamonds are said to have been found in auriferous ore close to Klerksdorp, in the southern part of the Transvaal. The gold-bearing ore at this point is reputed to be pudding stone of the Cape formation. The diamonds, of which somewhere about a score were found, were small and of a greenish tint.* I am not aware that any

*C. S. Goldmann, South African Mining and Finance, Vol. 2, 1895–6, page 29.

further finds were made at this point. If there is no mistake about this occurrence, there must have been diamonds in this region long before the intrusion of any known mass of kimberlite.

In the Orange Free State there are a number of localities at which the diamond has been found, although Jagersfontein is the only one which has yielded this gem in important quantities. The most northerly locality in the Free State of which I have heard is at Driekopjes, in the Kroonstad district. This district is bounded on the north by the Vaal River and it lies just south of Potchefstroom district, in the Transvaal. It is to be hoped that some geologist may eventually visit all the known diamond-bearing localities in South Africa and give the world the benefit of a comparative study.

GEORGE F. BECKER.

WASHINGTON, October 31, 1897.

CURRENT NOTES ON PHYSIOGRAPHY.

THE GREAT LAKES.

GILBERT'S discussion of 'Modification of the Great Lakes by Earth Movement,' presented to the Detroit meeting of the American Association, is published in the September number of the *National Geographic Magazine* (VIII., 1897, 233–247). It is truly astonishing that in the dozen years since the tilting of the ancient lake shore lines was recognized, and in our brief half century of accurate lake levellings, quantitative results as definite as those here announced should have been reached. A change of level of 0.42 foot per 100 miles per century in a direction about S. 27° W. seems to be assured. A line at right angles to this direction, drawn through the outlet of a lake, would have no change of level. All places on the lake shore northeast of such a line, or isobase, would emerge from the lake waters; all places to the southwest would be slowly submerged. Ontario lies altogether southwest of the isobase of its outlet; and, hence, the water must be encroaching on all its shores; the estimated rise at Hamilton being six inches a century. Erie is similarly situated, and the rise at Toledo is placed at eight or nine inches per century. The outlet isobase of Huron-Michigan leaves Huron altogether on the northeast, and crosses Michigan near its middle; the water surface must, therefore, be lowered ten inches a century on the northeast side of Georgian Bay, and six inches at Mackinac; while it must rise five or six inches at Milwaukee, and nine or ten at Chicago. "Chicago has already lifted itself several feet to secure better drainage, and the time will surely come when other measures of protection are imperatively demanded." In 500 or 600 years, high stages of the lake will discharge at Chicago by the ancient outlet of glacial Lake Michigan. In 1,000 years the discharge will occur at ordinary lake stages, and after 1,500 years it will be continuous. In about 2,000 years the discharge from Lake Michigan-Huron-Erie * * * will be equally divided between the western outlet at Chicago and the eastern at Buffalo. In 2,500 years the Niagara River will have become an intermittent stream, and in 3,000 years all its water will have been diverted to the Chicago outlet, the Illinois River, the Mississippi River and the Gulf of Mexico."

THE LAVA PLATEAU OF SOUTHEASTERN WASHINGTON.

THE lava plateau of the Columbia River basin, already described by Russell (Bull. 108, U. S. G. S.) a few years ago, now receives further attention from the same author (Irrigation Papers, No. 4, U. S. G. S.). A broad flat dome, uplifted 2,000 feet over the surrounding country and well dissected, forms the Blue Mountains; so well clothed with rock waste that one is astonished to learn that they are composed of

horizontal strata of basalt. From these mountains northward towards Spokane River the surface is nearly level with a deep soil cover; but it is here and there cut by deep canyons, on whose sides the lava beds form dark cliff belts. The Snake River crosses the Blue Mountain uplift in a canyon 4,000 feet deep and fifteen miles broad. The Grande Ronde, rising in many branches in the same mountains, has excavated an intricate series of branching canyons. Here the spaces between the streams are no longer flat-topped remnants of the original plateau, but sharp-edged ridges, diversified with spires and pinnacles. This river has cut a meandering trench in the floor of a flat canyon three miles wide, indicating two partial cycles of erosion. Many special features suggest interesting physiographic problems: the gravel terraces of Snake River, that once enclosed lakes in tributary streams; the falls of the Palouse, apparently the result of recent diversion of the river to a new and shorter course to Snake River; the wandering behavior of the Walla Walla on an aggraded floor, calling for special legislation regarding its use in irrigating canals; the deep fine soil on the lava plains, here and there heaped in hills, like dunes, and everywhere producing great crops of wheat in an apparently desert region. Nothing is more remarkable than the remnants of the prelava topography, whether seen in such eminences as Steptoe butte, rising over the lavas and never buried, or revealed in Snake River canyon, where a magnificent 'shut in'* occurs as the river cuts its superposed course through a deep-buried mountain of schist. Several excellent illustrations accompany the report.

HANDBOOK OF CANADA.

A HANDBOOK OF CANADA, published for the British Association meeting at Toronto last summer by the Local Committee, contains an account of the physical features of the Dominion by G. M. Dawson, conveniently condensed for ready reference. Thus the interior plateau of the Cordilleran region, occupying an area of 100 by 500 miles between the Gold range on the east and the Canadian Coast range on the west, is described as a peneplain of Tertiary denudation, greatly modified by Miocene volcanic accumulations and by the excavation of valleys after elevation. Its true character as a table-land cannot be appreciated until rising high enough for the eye to range along its even sky lines. Unlike the forested mountains east and west, this plateau has a drier climate, and includes wide stretches of grass-covered hills and valleys, forming excellent cattle ranges. It appears to be be correlated with the basin areas of Cordilleran region within the United States.

W. B. Dawson describes the Canadian survey of tides and currents; stating, among other things, that the current in Belle Isle strait is tidal, with a flow nearly equal in each direction. The accepted theory of a constant inward cold current is thus proved to be unfounded and misleading.

W. M. DAVIS.

HARVARD UNIVERSITY.

*See SCIENCE, III., 1896, 661.

CURRENT NOTES ON ANTHROPOLOGY.

THE ANCIENT MURMEX.

IN SCIENCE, April 16th, and later in No. 1, of the *Bulletin* of the Museum of the University of Pennsylvania, I announced the identification of the classical object usually called a 'bow-puller' with the *Murmex*, fastened to the fist in pugilistic contests. This identification met with general acceptance, but a few authorities of great weight, such as Sir John Evans and Professor E. S. Morse, offered against it the cogent objection that if the implement was so used, it could scarcely fail to be repre-

sented on some of the existing remains of classical art, and that none such, so far as they knew, could be adduced.

I am glad to supply this deficiency in my argument, and thus place my identification beyond question. When in Paris, in September, I examined the galleries of ancient art in the museums of the Louvre with this in mind, and was fortunate in finding a striking and beautiful example in point. It is No. 68 in the 'Salle des Caryatides,' and is labelled 'Athlete Vainqueur au Pugilat.' Each hand is wrapped in a cestus, and each is armed with a three-pointed *Murmex*, as accurately represented in the marble as this material allows. The statue is late Greek, from Rome, and the originals of the arms are now in Rome. No more conclusive evidence of my argument could be desired.

THE GODS OF THE MAYAS.

Serious students of the Mayan archæology will receive with great satisfaction the revised edition of the essay by Dr. Paul Schellhas on the figures of the gods in the Mayan manuscripts (Die Göttergestalten der Mayahandschriften, pp. 34, Dresden, Richard Bertling, 1897). It first appeared in the *Zeitschrift für Ethnologie*, 1892, but the author justly considers that the progress in this line of research called for a revision of the text. He pursues the same method as before, designating the divinities by letters, and discussing their proposed identifications as questions still open. All the important attempts in that direction are referred to, and such value assigned to them as he believes they merit. The mythological animals in the Codices are also named and figured, and their possible significations explained. The essay is dedicated to Dr. E. Förstemann, and certainly no one could be found more worthy of such a tribute.

A colored reproduction of page 11 of the Dresden Codex is given as the frontispiece, and a number of illustrations in the text render the descriptions clear to the reader.

ORIGIN AND IMPORT OF THE TOTEM.

The institution of the Totem, or something equivalent to it, prevailed widely in savage conditions of life in both hemispheres. It has generally been considered to indicate kinship, either real or ceremonial. Miss Alice C. Fletcher, in her paper on 'The Import of the Totem,' read at the Detroit meeting, takes up the totemic bond as found among the Omahas, and argues that among them it was not primarily a tie of relationship, but a purely religious lien, which connected together individuals and groups who had received similar revelations from the gods. These joined in certain similar rites and formed societies devoted to special cults. In this manner the gentes and tribes came to be based on spiritual, not physical relationship. Although the origin was thus in one sense individual, it is recognized that a man of uncommon ability and fortune might impress the group who dwelt together with the power of his totem, that is, his vision, and this would naturally be sought after and found by his descendants. This would unite the physical and spiritual kinship.

The paper is quite original in thought and founded on close personal study of the savage mind, as is evident on every page.

D. G. Brinton.

University of Pennsylvania.

NOTES ON INORGANIC CHEMISTRY.

Nature for September 23d contains an account of the series of micro-photographs of polished and etched surfaces of alloys, which were exhibited by Mr. J. E. Stead at the last conversazione of the Royal Society. These photographs show in many alloys, imbedded in the eutectic or what was once the mother liquor, crystals of alloys of definite

composition. Thus in copper-tin alloys rich in tin, crystals are found of the composition (approximate) Cu Sn, Cu_3 Sn_2 and Cu_2 Sn, according to the amount of copper present, the first mentioned separating from an alloy with 2% copper. In ternary alloys it has been found possible to detect two, and sometimes three, distinctly different compounds in the same microscopic field. The study of alloys by the microscope is a field which has hardly as yet been entered upon, but it promises very valuable results.

A NEW method for producing artificial diamonds is described by Dr. Q. Majorana in the *Rendiconti* of the Roman Academy. Carbon, heated in the electric arc is submitted to a pressure of 5,000 atmospheres generated by the action of an explosive compound on a small piston. The mass formed, which consists chiefly of graphite and amorphous carbon, is found to contain minute crystals, which show the properties of the diamond. It thus appears possible to transform amorphous carbon into the diamond directly without the medium of a solvent, which is used in Moissan's process.

THE manufacture of mosaic gold (sublimed stannic sulfid) by the sublimation of tin-amalgam, sal ammoniac and sulfur was known to the later alchemists, but the part played by the sal ammoniac in the process has been a matter of conjecture, though the old process is in use to-day. It is often possible to obtain the mosaic gold by subliming the precipitated stannic sulfid with sulfur, but unless sal ammoniac is present this method often fails. In the *Zeitschrift für angewandte Chemie* J. Lagutt clears up the reaction by showing that the chlorin of the ammonium chlorid forms with the tin the volatile tetrachlorid, which is in turn decomposed by the sulfur, giving the sublimate of mosaic gold, while the ammonium chlorid is re-formed. Ammonium bromid can be substituted for the sal ammoniac, but no other ammonium salt. The formation of the mosaic gold from the direct sublimation of stannic sulfid and sulfur is accounted for by the presence of hydrochloric acid in the stannic sulfid. If this is thoroughly washed free from hydrochloric acid no mosaic gold is found.

FROM the new Davy-Faraday Research Laboratory comes a solution of another of the problems of the past. In 1841 Grove described a class of metallic nitrogen compounds to which he gave the name of 'nitrogurets.' These were formed by the action of six Grove cells on a concentrated solution of ammonium chlorid, with anode of zinc, cadimum, copper, etc., and kathode of platinum. Grove supposed the deposits to be compounds of ammonium analogous to ammonium amalgam, or of nitrogen and the metals. In the *Zeitschrift für Electrochemie* Heinrich Pauli describes a repetition of the experiments carried out in the Davy-Faraday Laboratory, and shows that with zinc anode Grove's zinc nitroguret is merely metallic zinc. With copper anode the deposit is a mixture of cuprous oxid and metallic copper, and with silver anode, silver oxid or silver according to the intensity of the current.

THE proposal of Carnot to determine the geological age of a fossil by the relative quantity of fluorin and phosphate present has been applied, at the request of Dubois, the discoverer of the fossil remains of *Pithecanthropus erectus*, to determine whether this interesting specimen is really Pliocene. J. M. Van Bemmelen gives an account, in the *Zeitschrift für anorganische Chemie*, of an examination of the remains of a fossil elephant found in the same stratum with the *Pithecanthropus*. He finds the ratio of fluorin to phosphate in comparison with that of apatite to be 0.53, which is very close to 0.58, that given by Carnot as

characteristic of Pliocene fossils. This is a confirmation of the geological and paleontological evidence as to the age of the fossil.

SOME time since Dr. Matteucci announced the discovery of selenium in the fumarole products of Vesuvius. He now adds, in the *Rendiconti* of the Naples Academy, bromin and iodin, found for the first time in these products, though their existence was theoretically probable.

FROM an Associated Press dispatch of October 15th, we note the following, dated Berkeley, Cal.: "Gold from silver is not an impossibility, according to Edmund O'Neill, associate professor of chemistry at the University of California."

J. L. H.

SCIENTIFIC NOTES AND NEWS.

THE AMERICAN SOCIETY OF NATURALISTS.

THE American Society of Naturalists and the affiliated societies will meet at Ithaca, N. Y., on December 28th, 29th and 30th. All the societies will assemble in Sage College at 1 p. m., on Tuesday, December 28th, when an address of welcome will be made by President Schurman. The chief meeting of the Naturalists in which the other societies join is on Wednesday afternoon, for which the following program has been arranged:

I. Reports of Committees.

II. Election of new members.

III. Appointment of Special Committees.

IV. Discussion. The Biological Problems of To-Day.

Paleontology, Professor H. F. Osborn, Columbia University.

Botany, Professor Wm. Trelease, Missouri Botanic Gardens.

Anatomy, Professor Burt G. Wilder, Cornell University.

Psychology, Professor J. McKeen Cattell, Columbia University.

Physiology, Professor Jacques Loeb, University of Chicago.

Developmental Mechanics, Professor T. H. Morgan, Bryn Mawr College.

Morphogenesis, Professor Charles B. Davenport, Harvard University.

(The time allowed each speaker will be limited to ten minutes.)

Special Papers.

In the evening there will be the business session of the Naturalists and the annual dinner of the societies, at which the President, Professor C. O. Whitman, will make an address. The Ithaca Hotel will be the headquarters, but there are many excellent boarding houses at the campus, and the University will provide a luncheon each day. The members of the local committee are: Chairman, Professor S. H. Gage; Secretary, Professor W. W. Rowlee; Professor G. C. Caldwell, Professor B. G. Wilder, Professor I. P. Roberts, Professor S. G. Williams, Professor R. S. Tarr, Professor P. A. Fish, Professor E. L. Nichols, Professor L. A. Wait, Professor E. B. Titchener, Professor G. F. Atkinson, Professor L. H. Bailey.

The officers of the Naturalists are: President, C. O. Whitman; Vice-Presidents, H. P. Bowditch, E. B. Wilson, W. P. Wilson; Secretary, H. C. Bumpus; Treasurer, John B. Smith; other members of the Executive Committee, elected from the Society-at-large, Leslie A. Lee, George H. Parker.

The other societies meeting with the Naturalists are: The Association of American Anatomists, The Association for Botanical Morphology and Physiology, The American Morphological Society, The American Physiolgical Society, The American Psychological Association, Section H. (Anthropology) of the American Association for the Advancement of Science. The New York State Science Teachers' Association will meet at Ithaca, December 30th and 31st.

GENERAL.

THE National Academy of Sciences will hold its winter meeting next week in Boston, beginning on Tuesday, November 16th.

A COPE memorial meeting will be held in the Hall of the American Philosophical Society, Philadelphia, this evening, under the auspices of institutions with which Professsor Cope was connected. Addresses on the services to science by Edward Drinker Cope will be delivered as follows: Dr. Theodore Gill, Work in Fishes, Batrachia and Reptiles; Professor Henry F.

Osborn, Work in the Mammals; Professor William B. Scott, Contributions to Geology. The following delegates have been appointed to represent the cooperating associations on this occasion: A. S. Packard, National Academy of Sciences; William H. Dall, United States Geological Survey; Theodore Gill, American Association for the Advancement of Science; Henry F. Osborn, American Museum of Natural History; E. G. Conklin, University of Pennsylvania; Harrison Allen, Academy of Natural Sciences; William B. Scott, Wagner Free Institute of Science; William Pepper, American Philosophical Society.

REV. DR. SEARLE has resigned from the directorship of the astronomical observatory of the Catholic University of America, and Mr. Alfred Doolittle has been appointed to succeed him.

DR. W. v. BEZOLD, of Berlin, was awarded, on the occasion of its jubilee celebration, the gold medal of the Prussian Meteorological Institute.

THE Royal College of Physicians, London, has conferred the Baly Medal, given every three years for research in physiology, on Professor Schäffer, of University College, London.

QUEEN VICTORIA has conferred the Jubilee Medal upon Sir George Duffey, President of the Royal College of Physicians in Ireland, and upon Sir William Thomson, President of the Royal College of Surgeons in Ireland.

THROUGH *Nature* we learn that the Reale Accademia dei Lincei has recently elected the following associates and correspondents: National associate, in the section of zoology and morphology, Professor G. B. Grassi; correspondent, in the same section, Professor G. Fano; foreign associates in mathematics, Professors H. Weber and T. Reye; in mechanics, Professor G. H. Darwin; in mathematical and physical geography, Professor F. R. Helmert; in geology and paleontology, Professor A. Gaudry; in physiology, Professors H. Kronecker and O. Schmiedeberg.

DR. FOREL, professor of psychiatry in the University of Zurich and Director of the State Asylum for the Insane, has resigned these offices, owing, it is said, to the attacks made upon him by the press for the part he has taken in combatting the use of alcohol.

SIR RUTHERFORD ALCOCK died in London on November 2d, aged eighty-eight years. He had been President of the Royal Geographical Society and had published works on geography and hygiene.

A MEETING of the general committee having in charge the arrangements for the next International Congress of Zoology was held on November 4th. It will be remembered that the Congress meets in Cambridge on August 23d under the presidency of Sir William Flower.

THE Royal Academy of Belgium offers a series of prizes for 1898, the subjects of which are published in the *Revue Scientifique*. Four questions are proposed in mathematics and the physical sciences and three in the natural sciences, for the best answers to which small prizes (600–800 francs) are offered. The essays must be presented by the first of August, 1898, and we understand that foreigners may compete, though the MSS. must be in French or Dutch. A prize of 1,000 francs for the best work in astronomy by a Belgian is also offered. Further details regarding these prizes may be obtained from the Secretary of the Academy, Palais des Académies, Brussels.

SIR JOSEPH NORMAN LOCKYER, accompanied by Dr. W. J. S. Lockyer and Mr. A. Fowler, of the Royal Astronomical Society, will leave London on December 10th for Colombo to observe the total solar eclipse of January 21, 1898.

THE success attending the recent expedition of Mr. J. B. Hatcher, of Princeton University, as reported in a recent number of SCIENCE, has led him to return to that country to continue his investigations in paleontology and geology. Mr. Hatcher will land at Punta Arenas, in the Strait of Magellan, and will proceed northward to Chubut. In addition to paleontological collections, Mr. Hatcher expects to secure collections of natural history and ethnology.

MR. F. W. W. HOWELL proposes to attempt the ascent of Mt. Everest next year, and is said to have the cooperation of the Royal Geographical Society and the government of India.

PROFESSOR LAWRENCE BRUNER, of the Uni-

versity of Nebraska, whose departure for Argentine to study the plague of locusts we at the time noted, has safely arrived and is engaged in studying methods of mitigating the plague.

THE Philadelphia museums have in working order their 'Laboratory of Tests and Technology,' to be operated in connection with the other work now being done by the Commercial Museum. The laboratory is maintained as an adjunct of the scientific department, of which Gustave Niederlien, now absent in Central America, is the chief. The work of the laboratories, however, is under the immediate direction of Dr. Louis J. Matos.

THE firm of Siemens & Halske, electrical engineers, celebrated last month the fiftieth anniversary of the foundation of the firm. The firm established a fund of 1,000,000 Marks for the benefit of its workmen and officers, and appointed a committee to consider the best use to be made of the money. Herr Wilhelm Siemens delivered a speech, dwelling upon the two guiding principles of the firm, namely, scientific research and perfection of work.

THE British government has declined to take part in the Florida Fisheries Conference, stating that, while greatly interested in the objects of the Conference, it is unable to send an official representative.

THE opening meeting and exhibition of the Röntgen Society was held in St. Martin's Town Hall on November 5th. Professor Sylvanus P. Thompson gave a presidential address.

WE learn from *Garden and Forest* that a State Forestry Society was organized at Raleigh, North Carolina, on October 21st, with fifteen members. The Society elected Mr. W. E. Petty, Carthage, President; Dr. C. A. Schenck, Biltmore, Vice-President; Professor W. W. Ashe, of the North Carolina Geological Survey, Secretary and Treasurer. The main object of the Society is to lessen forest fires in North Carolina, which are doing great injury to pine lands, especially in the southeastern part of the State, in the valley of the lower Cape Fear River. Methods of improving the condition of lumbered and deteriorated woodland will also be considered, and the re-establishment of waste and eroded agricultural lands in timber.

AT the Wagner Free Institute of Science, Philadelphia, ten weeks' courses are now being given in the evenings as follows: Mondays, Professor S. T. Wagner, 'Engineering Materials;' Tuesdays, Professor W. B. Scott, 'Historical Geology;' Wednesdays, Professor R. E. Thompson, 'History;' Thursdays, Professor G. F. Stradling, 'Magnetism;' Fridays, Professor Henry Leffmann, 'Chemistry;' Saturdays, Professor Emily G. Hunt, 'Chapters from the Life of Plants.' These courses are now in session.

AT a recent meeting of the Board of Directors of the American Chemical Society it was decided to appoint a committee of three, with Dr. Wiley as chairman, with power to take charge of a want column in the *Journal* of the Society. Members of the Society seeking positions, and, also, persons desiring to employ chemists, will be allowed a three and one-half inch advertisement free of charge.

A NEW building for the chemical laboratory of the University of Berlin is now in course of erection, at a cost of about $250,000. It will contain four large laboratories, with desks for 250 students and 25 research rooms.

A PASTEUR Institute was opened in Sofia on October 18th.

PROFESSOR WILTSHIRE has presented to the mineralogical museum of Cambridge University his collection of minerals, which includes numerous specimens of high scientific value. The zoological museum has also been enriched by the addition of a collection of polyzoa presented by Miss E. C. Jelly, and of the skeleton of an elephant seal, the gift of Sir W. L. Buller.

THE New York *Evening Post* reports that Prince Roland Bonaparte has been paying the expenses of meteorological experiments made in the upper strata of the atmosphere with a balloon presented to the Central Meteorological Bureau by M. Balaschoff.

ESSAYS in competition for the Alvarenga prize of the College of Physicians of Philadelphia must be sent to the Secretary of the College by May 1, 1898. The value of the prize is about $180 and the essay may be upon any medical subject.

THE publication of the *Academische Revue*, which has contained full news and valuable

discussions of university education in Germany, will, we regret to learn, be suspended, owing to lack of financial support. The *Hochschul-Nachrichten* will, however, be continued at a cost of 6 Marks per annum.

IN the address on behalf of the faculties of the University of Chicago at the dedication of the Yerkes Observatory, described elsewhere in the present issue, President Harper gave details regarding the cost of the equipment. There was first of all the forty-inch objective, the greatest and last work of its maker, Alvan G. Clark. This objective cost, when finished, $66,000; the equatorial mounting, and the dome and rising floor cost $55,000 and $45,000 respectively. To these there must be added, as distinct gifts, the 30-foot dome for the southeast tower which cost $7,000, the 26-foot dome and mounting of the Kenwood telescope; likewise the stellar spectrograph, constructed by Mr. J. A. Brashear, costing $3,000. Besides all these, the building with its piers for the instruments, its steam-heating plant, engines, dynamos and motors, the cost of which has been in round numbers $135,000. Acknowledgment was also made of three additional gifts which had already come to the Observatory: The grounds on which it has been built, consisting of 55 acres valued at $50,000, a contribution of Mr. John Johnston, Jr.; the instruments and equipment of the Kenwood Observatory, presented to the Yerkes Observatory by Mr. William E. Hale, and the gift of Miss Catharine Bruce, of New York City, of $7,000, for a ten-inch photographic telescope with building and dome.

MR. H. C. COOPER writes us from Heidelberg calling attention to a curious exhibition of paternalism on the part of the University. All students doing laboratory work, and even attending experimental lectures in chemistry or physics, are *required* to take out an accident insurance policy covering accidents occurring in the exercises. Students entirely disabled are to receive $500 per annum, with a corresponding allowance for lesser injuries. The risk is probably not as great as outsiders may suppose from this regulation, as the premium for lecture courses per semester is only two and a-half cents.

PROFESSOR J. A. UDDEN, of Augustana College, Rock Island, Ill., writes us that Dr. N. O. Holst, of the Geological Survey of Sweden, has lately had two years' leave of absence from his work on the Survey for the purpose of studying the new gold fields in western Australia. After leaving this southern continent he visited New Zealand, China, and Japan, and then returned by way of Canada and the United States. He has seen the ancient Australian glacial deposit which is supposed to belong to the Permian age, and he says there can be no doubt but that it is an indurated boulder-clay. Its age may possibly be somewhat later than heretofore supposed, but not so much later as to detract from the importance of its bearing on the subject of geological climate. In the semi-desert, where Dr. Holst spent most of his time, the wind did not appear to him to be of any great importance as a geological agent, although dust storms are sometimes reported from the new towns on the border of the desert. One of the Australian geologists has lately made some interesting observations on what resembles a tidal action of the ground water in the sandy region in the interior. The water rises and falls at regular daily intervals, and the oscillations appear to be too great to be explained as resulting from the daily variations in atmospheric pressure.

A CORRESPONDENT writes to the London *Times* that the site of the prehistoric Celtic lake village near Glastonbury has been further excavated since July last, under the superintendence of the discoverer, Mr. Arthur Bulleid. The sites of the dwelling are marked by mounds. One of these contained the greatest depth of clay yet found, no less than 9 feet; the accumulation of successive hearths which were found necessary as the weight of the clay gradually compressed the peat beneath. This mound contained 300 tons of clay, all of which must have been brought in their boats by the inhabitants from the neighboring hills. Under the mound was found the framework of a loom with brushwood and wattlework to form the foundation. That the inhabitants were much engaged in spinning is clear from the fact that, in addition to other things connected with the craft, no fewer than forty horn and bone carding combs

have been unearthed. The number of broken bone needles and splinters of bone found in one mound seem to indicate that it was utilized as a needle factory. Another mound was very rich in fragments of pottery and other evidences of the manufacture of hardware. As usual, very few human remains were discovered, part of the skeleton of a very young child being all that was brought to light this summer. With the exception of the cracked skulls of a few unfortunate warriors, the remains of very young children have chiefly been found in past years, Mr. Bulleid being of the opinion that these primitive people conveyed their dead to the neighboring hills for interment. Parts of three broken millstones were unearthed, and in one mound a clay oven, measuring 2 feet by 9 inches. One glass article only was brought to light this year, a blue glass bead with a wavy line of dark blue running round it. Altogether the season's work has proved very interesting, and the British Association is so well satisfied with the discoveries made from time to time that at their Toronto meeting they renewed their grant towards the excavation fund.

A MUSEUM of Natural History and Anthropology was opened at Wernigerode on July 29th. It was planned by the late Prince Otto von Wernigerode and will be named after him. The Museum contains the mineralogical collections of Count Heinrich Ernst, Councillor Jasche and Dr. Döring, the herbarium of Dr. Sporleder, the zoological collections of Dr. Müller and the anthropological collections of Dr. Augustin and Dr. Friedrich.

THE last number of the *Journal* of the Marine Biological Association of the United Kingdom contains the annual report of the Director and of the Council for 1896–97. According to the notice in *Natural Science*, the Plymouth station continues to flourish and increase in utility under the direction of Mr. Allen. The Association is also fortunate in retaining the services of Mr. Holt, for the time being, as Honorary Naturalist. The Lords Commissioners of H. M. Treasury, in granting the usual £1,000 for the year 1897–98, have made it a condition that the Association will give all the assistance in its power to the Inspectors of Irish Fisheries in investigations which they desire to be made on the habits and migrations of the mackerel visiting the Irish coast. This work has thus been begun, and the principal contribution to the new number of the *Journal* is Mr. Allen's report on the present state of knowledge with regard to the habits and migrations of the mackerel (*Scomber scomber*). Most of the other papers also have an important economic bearing. The large laboratory in the Plymouth station has been provided with a new flat tank, eight feet by five feet and eight inches deep, in which Mr. Garstang has been making observations on crustacea. The sea water supplied to the laboratory is still kept distinct from the general circulation in the show tanks, and is never returned to the laboratory tanks after it has passed through them. Experience shows that the theory of 'circulation,' as applied to aquaria, is illusory and in practice disastrous.

THE United States Department of Agriculture has issued a circular by Mr. B. E. Fernow, Chief of the Division of Forestry, on recent legislation on forest reserves. It includes an account of the federal legislation to which during the year we have frequently called attention, and to legislation in Minnesota, Wisconsin, Pennsylvania and New York. In view of the importance of the action of the New York Legislature in enlarging the Adirondack Park, it may be well to give the constitution of the Commission of Fisheries, Game and Forests, under the law of April 25, 1895. This law is a comprehensive measure in which allied interests are brought under the control of a single board. The commission consists of five members appointed by the Governor with the consent of the Senate, the term of office being five years. The President, who is designated as such by the Governor, receives a salary of $5,000 per year and traveling expenses, and devotes all his time to the work of his office. The remaining four commissioners each receive $1,000 per year and traveling expenses. The board holds at least four meetings, on designated days, each year. It has a secretary at $2,000 per year, and necessary clerical force. The duties of the board are to propagate and distribute food-fish and game; to enforce all laws for the protection of fish and game and

for the protection and preservation of the forest reserve. It has full control of the Adirondack Park and forest reserve, and is authorized to make rules for its care and safety. The commission appoints thirty-five 'fish and game protectors and foresters,' one of whom is known as chief, and two others as his assistants, the chief to have direction and control of the entire force. The chief forester receives $2,000 per year and traveling expenses; the assistant foresters $1,200 each; and the remaining foresters $500 each; all having an extra allowance for traveling expenses and each of them to receive one-half of all fines collected in actions brought upon information furnished by them.

THE Cairo correspondent of the London *Times* writes: "The crime statistics for the first three quarters of this year, compiled by the Minister of the Interior, show a gratifying diminution, which is confirmed by the registers of the Ministry of Justice. The figure has fallen from 1,493 cases in the corresponding period of 1896 to 1,143—a decrease of over 23 per cent.; and robberies with violence, which constitute the most serious class of crime in Egypt, have diminished from 476 to 287, or nearly 40 per cent. The fact that the decrease is distributed generally over the country and has occurred steadily month by month shows that it is due, not to any accidental circumstances, but to better organization and control, and indicates a real advance in the state of public security throughout the country."

UNIVERSITY AND EDUCATIONAL NEWS.

PRESIDENT MCKINLEY will deliver the oration on 'University Day,' to be observed by the University of Pennsylvania, on Washington's Birthday.

THE Association of Colleges and Preparatory Schools in the Middle States and Maryland will meet this year at Vassar College, Poughkeepsie. On November 26th and 27th Professor Ralph S. Tarr and Mr Charles C. Wilson will introduce the discussion of science in the schools, which is assigned an important place on the program.

AT the annual meeting of the Council of New York University, on November 1st, Chancellor MacCracken presented a report covering the work of the University for the past twelve years. It appears that when Dr. MacCracken first became connected with the University, in 1885, the value of its property was only about $600,000, whereas it is now nearly $2,500,000. The gifts last year amounted to more than $250,000.

THE Teachers' College, New York, shows a marked growth this year, the number of students being two hundred and forty-one, against one hundred and twenty-nine last year.

IT is expected that a Hall of Physics will be built at Syracuse University next year, the sum of $25,000 having already been subscribed for the purpose.

AT the last meeting of the Board of Trustees of the University of Alabama Mr. George S. Wilkins (Princeton) was elected professor of civil and mining engineering, and Dr. John Y. Graham (Princeton) professor of biology.

DR. FRANK K. CAMERON, late associate professor of chemistry in the Catholic University of America at Washington, has been appointed research assistant in physical chemistry in Cornell University.

DR. WARNER FITE, assistant professor of philosophy in Williams College, has been appointed to a docentship in philosophy in the University of Chicago, and Mr. A. F. Buck and Miss Jane Downey have been appointed assistants in the psychological laboratory.

THE chair of philosophy and the chaplaincy of Lehigh University have been filled by the election of the Rev. Langdon C. Stewardson, rector of St. Mark's Episcopal Church, Worcester, Mass.

DR. MAX VON FREY, of Leipzig, has been called to the chair of physiology at the University of Zurich, and Dr. George Kraus to the chair of botany in the University of Halle, as successor of Professor J. von Sachs.

DR. MAX DESSOIR has been promoted to an associate professorship of psychology in the University of Berlin, Dr. Lothar Heffter has been made associate professor of mathematics at the University at Bonn, and Dr. Brikencajer

associate professor of mathematics at the University of Krakau.

DISCUSSION AND CORRESPONDENCE.

HOW TO AVOID THE DANGERS OF FORMALIN.

To the Editor of Science: In the issue of Science for October 22d I note a letter by Dr. Dall, of the United States National Museum, in which the use of formalin for the preservation of zoological objects for dissection is declared to be dangerous to the cuticle, to the digital neural terminals and to the eyes of the dissector.

When working with formalin my eyes and nasal passages have been affected and it seemed to me that its use might be fraught with some danger. But the effect of the gas arising from specimens and of the solutions has never given in my case such serious trouble as seems to have been given the person of whom Dr. Dall speaks. To be contrasted with the effects of the reagent in this case is the fact that formalin and formaldehyde have come to be regarded as very important germicidal disinfectants to be used in inhabited rooms, where, we are told by members of the medical profession to which Dr. Dall appeals, that their use need not endanger in any way the inhabitants. Special lamps are on the market for generating formaldehyde from wood alcohol, and to be used in just such rooms. There may also be noted an experiment performed upon a calf, in which the animal was exposed for five hours to an atmosphere containing about 2% of formaldehyde. The only noticeable effect was a slight cough and a slight watering of the eyes, both of which disappeared upon bringing the animal into fresh air. What might have happened had the animal been subjected to such an exposure daily for several weeks is a question that remains to be solved. In view of the fact that formalin seems destined to be used to a very great extent in laboratories and museums, and also in view of its having been recommended as a disinfectant to be used as noted above, experiments to determine how great an exposure eyes, cuticular organs and mucous membranes can stand without injury can have nothing less than a very great importance.

But even though the use of the reagent is as dangerous as the case of the slug dissector mentioned by Dr. Dall would lead one to think, such dangers may be obviated by taking advantage of the strong affinity formaldehyde and ammonia have for one another. In rooms where formaldehyde is used dishes of ammoniated water may be placed, and specimens preserved in formalin may be washed in ammoniated water before dissection, with the result of completely neutralizing the effects of the disinfectant or preservative.

F. C. Kenyon.

Washington, D. C.

PROFESSOR CATTELL'S REVIEW OF 'SIGHT.'

I rarely ever reply to any criticism of a work of mine. I never do so unless to explain something misunderstood. But in the case of Professor Cattell's review of 'Sight' in Science for September 24th, I feel the less hesitancy because of his generous estimate of its value. There are three points on which I wish to explain myself more fully.

1. Professor Cattell objects to my view that "the central spot is necessary to the development of the higher faculties of the mind," and asks in rejoinder: "May not the mental faculties of the born-blind be developed?" And well might he object if I implied anything so absurd. But he has entirely mistaken my meaning. Perhaps I am partly responsible for a possible ambiguity, and, therefore, thank him for drawing my attention to it. I did not mean development of the higher faculties in the *ontogeny*, but in the *phylogeny*, of man; not in the education of the *individual*, but in the origin of the *race*. Perhaps, however, I ought to have used the word *evolution* instead of development. I shall make the correction.

2. Again Professor Cattell objects to my saying: "We see things double except under certain conditions." He says: "This is bad psychology. We *learn* to see them double." Of course, we learn to consciously see them double. But if we see only what we consciously see, we see comparatively little. The phenomena of double vision lie so near the surface of consciousness that the least attention recalls them. They may be called subconscious, but we base our judgments on them all the time. Surely it is the business of psychology to bring

into clear consciousness phenomena which underlie so much of our daily conduct.

3. The last point which I wish to touch is again the much discussed question of *upright vision*. I feel like apologizing for bringing up this question again; but I am convinced that much of the difference of view is the result of misunderstanding. For example, I explain upright vision by the *law of direction*. Now, surely, Professor Cattell must misunderstand the explanation when he talks of standing on one's head and still seeing things upright as controverting that law. The law of direction explains uprightness equally well, whatever be the position of the observer. I am sure the question has been obscured and the mystery intensified by that wonderful inverted retinal image. But seeing things upright is not necessarily connected with an inverted image. It is easy to imagine an eye so constructed that the retinal image shall be upright, and yet by the law of direction the object shall also be seen upright. We probably have something like this realized in the case of insects. The compound eye of insects is so constructed of slender tubes lined with pigment that only the central rays of each radiant pencil can reach and impress the retina, all others being quenched by striking on the sides. This, as shown by the figure, would make an upright

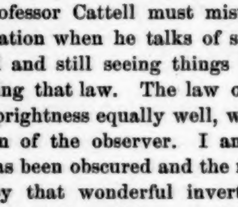

FIG. 1. Diagram showing the upright image in the eye of an insect.

image, and yet by the law of direction the object would be seen upright also. Our retina is *concave* instead of convex. It is so because the image is inverted, and, therefore, must be re-inverted in the act of outward reference.

The marvellousness of the inverted image has diverted attention from the real question, which is, the seeing things in their true places. A child only a few days old will turn the eyes toward a bright light. Is there anything so mysterious in this? But why *toward*, unless it saw the light in its true direction? Now, upright vision is only a case under this more general fact; for objects are made up of an infinite number of lights or radiants and each is seen in its true direction, and, therefore, the object in its true position.

Professor Cattell refers to the recent experiments of Dr. Stratton* as controverting the law of direction, although he thinks a much easier way of doing so 'is to stand on one's head.' I am glad to have the opportunity to express my admiration of these experiments of Dr. Stratton, and my high estimate of their value; and I cannot think that the simpler mode suggested by Professor Cattell would be at all an adequate substitute. In brief, the experiment consists in the wearing of inverting glasses continually for eight days. The experimenter for that length of time never saw things except reversed. The ground was above and the sky below, things on the right were seen on the left, and *vice versa*. And yet by the end of the experiment all the movements of the body were so adjusted to the new conditions that he could walk the streets with comparative comfort.

This seems very extraordinary, and it is possible that we may have to reconstruct some of our fundamental conceptions of space; but evidently it does not controvert the law of direction. If we only think a moment, we shall see that we already have phenomena approaching in various degrees the extreme conditions of this experiment, but they are so familiar that they do not strike us with wonder. In looking in a mirror one image is *partly* inverted, *i. e.*, it is turned about a vertical axis—it is inverted from side to side, but not up and down. And yet, we easily adjust our movements to the changed conditions. We make complex movements, such as tying a cravat, with ease and accuracy.

Again, in looking through a microscope the image of the object is *completely* inverted, *i. e.*, it is turned about the visual axis 180°; and, yet, with a little practice, we adjust our movements to the new conditions. We slide the object in all directions accurately and even

* Psych. Rev. for July and September.

automatically, although to do so we must move it in a direction exactly contrary to what the image seems to require.

Now, Dr. Stratton's experiment goes one step farther. In this, not only an object, but the *whole external world*, including the visible parts of the body, are inverted. Not only some, but *all* our movements must be readjusted. The results are certainly surprising and may possibly require some reconstruction of fundamental conceptions of space—how much I am not prepared to say, but they certainly do not affect the law of direction properly understood.

The law of direction gives nothing but *the direction of the impressing force*, and this it gives always. Under *normal* conditions, *i. e.*, when the light comes straight, and without deviation from the object to the eye, it gives the true places of objects and radiants, and therefore upright vision; but not under *abnormal* conditions of deviation of the light. For example, we look at an object in a mirror inclined 45° to the line of sight. The apparent object is seen far away, 90°, from its true place; but this does not violate the law of direction, but confirms it. We see in the direction of the impressing force, which in this case—in all cases—is the *last direction of the light.* Again, in gazing at an object through a microscope, we see it inverted, *i. e.*, the radiants are seen in wrong places. But this does not violate the law of direction. We still see every radiant in the direction of the impressing force, but that direction has been changed so as to give wrong places.

So in Dr. Stratton's experiment. At first, at least, we see things in wrong places, *i. e.*, wrong as judged by the deliverances of other senses, but yet in strict accordance with the law of direction, *i. e.*, in the direction of the impressing force. As to the final result of an indefinite continuance of these experiments and whether complete accord in the deliverances of all the senses would ever be reached, so that things would again seem natural as they do now, this seems to me a question of philosophy rather than science, or, perhaps, I should say of psychology rather than physiology. I am not now concerned with it.

But it must be clearly understood that the law of direction is purely a *formal* law, *i. e.*, a law which groups consistently all the facts concerning the relative places and positions of objects in the external world *as we know it*. This is all that it pretends to do. The discovery and announcement of such general formulæ is the main function of science. As to what the external world is, and what space and direction are, that is another matter. These more ambitious questions belong to philosophy, not to science.

In conclusion, I have said that the law of direction is inherited, not acquired. By this I do not mean that in the last analysis it is not due to experience. It does, indeed, come from experience, but not mainly from *individual* experience. It is the result of *ancestral* experience, inherited all along the line of evolution ever since eyes were formed, and finally embodied in brain structure.

JOSEPH LE CONTE.

BERKELEY, October 11, 1897.

WHEN an author replies to a reviewer it is but courteous for the latter to try to show that he has not been careless in his statements.

1. Professor Le Conte's statement (page 78), "I believe that the existence of the central spot is necessary to fixed, *thoughtful attention*, and this again in its turn is necessary for the development of the higher faculties of the mind," I understood to refer both to individual development and to race evolution. The limited field of distinct vision and the associated eye-movements seem to me factors or correlates in the evolution of attention, but by no means 'necessary.' That is a dangerous word to apply to nature, which works in many ways. Most men may be 'visuals', but some of us are 'motiles'; the horse is an 'audile,' the dog an 'olefactor'. As a matter of fact, Professor Le Conte makes a mistake in stating that the 'central spot * * * exists only in man and in the higher monkeys' with a foot-note to the effect that in different forms it is found in some birds. Knox in 1823 described the central spot and fovea in lizards and they have been found in fishes by Carrière, Krause and others. A central spot, *i. e.*, an area of acute vision, has been described in nearly all mammals, though the fovea is probably only present in the pri-

mates.* Professor Le Conte maintains not only that "the fovea is necessary to the concentration of the attention on the thing looked at," but also (p. 302) that "the existence" of the fovea is determined by "the habits of the animal, especially in looking attentively."

2. I regard it as either bad psychology or bad terminology to say: "We do, indeed, see all objects double except under certain conditions." We do not hear each of the overtones of a tone because most people can learn to distinguish them, nor do we know the motives of our actions because we believe that motives exist.

3. I am glad that Professor Le Conte here calls attention to the real psychological problems involved in localization in the field of vision and in the coordination of visual and motor perceptions. The section in his book which I criticised is, however, headed 'Erect Vision,' and he writes: "How, then, with inverted retinal images, do we see objects in their right position, *i. e., erect?* This question has puzzled thinkers for many centuries," etc. The question seems to me analogous to that of the child who asks how people in China with their heads down can hang on by their toes. It may be a popular paradox, but I do not admit that it is a question deserving serious scientific discussion. J. MCKEEN CATTELL.

* For the most recent work on the subject *cf* the thesis by Dr. Slonaker in the *Journal of Morphology* XIII., 3. Professor Le Conte himself in a later chapter refers to a more highly organized central area in the lower mammals.

A SIMPLE METHOD OF COMBINING THE COLORS.

THE following very simple method of illustrating the recomposition of the spectral colors into white light has some obvious advantages in the way of ease of apprehension on the part of the beginning student. It also possesses an additional and not inconsiderable advantage in that it is striking.

A rectangular refraction tank with glass ends is set up in front of the lantern, both being preferably upon a rotating stand. From a horizontal slit a beam is projected and the prism interposed in such a manner that there is sent down into the water the rays of the spectrum, their order from red to violet running lengthwise of the tank. A few drops of milk are mixed with the water, and with care a mixture may be obtained which in a side view shows the separated rays clearly, while at the same time if viewed from the end of the tank it looks quite white. On cutting off either the violet or red end of the spectrum the end view becomes colored.

If a strong beam is available it is better to turn it back toward the lantern by a reflector before sending it through the prism. This brings the violet rays which are least intense nearest the end, where they have to traverse a thinner stratum of the mixture.

F. W. MCNAIR.

MICHIGAN COLLEGE OF MINES.

SCIENTIFIC LITERATURE.

Report of Explorations in the Labrador Peninsula along the East Main, Koksoak, Hamilton, Manicuagan and the Portions of Other Rivers in 1892–93–94–95. By A. P. LOW, B. Ap. Sc. Annual Report of Progress, Geological Survey of Canada, Vol. VIII., pp. 385.

One of the most interesting and valuable reports which has been issued by the Geological Survey of Canada in recent years has just appeared on the peninsula of Labrador, by Mr. A. P. Low.

The report embodies the results of four years' exploration, during which time Mr. Low has traversed Labrador from north to south and from east to west, and it presents in readable form a summary of our knowledge, not only of the geography and geology, but also of the climatology, botany, zoology and natural resources of this remotest part of the Dominion, the interior of which, prior to Mr. Low's exploration, was practically unknown. Mr. Low's work, the results of portions of which have been previously published in preliminary reports to the Geological Survey, and in papers presented to various scientific societies, has attracted much attention and has recently been accorded an especial recognition by the Royal Geographical Society of England. The report is accompanied by a fine map of Labrador, in four sheets, on a scale of 25 miles to the inch, which is colored geologically along the lines

of traverse, and it is illustrated by a number of views showing the character of the country, among them one of the Grand Falls of the Hamilton River, concerning which there was so much discussion a few years since.

The peninsula may be described as a high rolling plateau having a general elevation of from 1,600 to 1,800 feet, the surface sloping rapidly down towards the Atlantic and Gulf of St. Lawrence, but much more gently toward James Bay. To the north of Nain the high land of the coast rises in sharp unglaciated mountains to the height of from 2,500 to probably 6,000 feet.

One of the most remarkable physical features of the country are the deep cañons or fjords followed by all the rivers draining the interior where they cut through the margin of the peninsula and run out to sea. These have rock walls from 1,000 to 4,000 feet in height, while the river channels are from 10 to 100 fathoms deep. They appear to be valleys of deundation and are of very ancient origin, antedating the Cambrian, undisturbed horizontal beds of this age being found deposited upon their lower levels. The gorges of the Hamilton, Sandwich and Kaipokok might be cited as examples, as well as those of the Moisir and Saguenay, discharging into the Gulf of St. Lawrence.

About nine-tenths of Labrador is underlain by rocks of Laurentian age, and, like all the rest of the glaciated Laurentian country, the plateau is studded with myriads of lakes, great and small, which are estimated to occupy at least one-fourth of the total surface, and which are drained by a network of streams discharging into the deep fjords above referred to. The peninsula is underlain exclusively by the oldest rock systems of the earth's crust, the Laurentian, Huronian and Cambrian, besides certain rocks of intrusive origin. The Laurentian rocks differ in no essential particular from those found elsewhere in Canada. Both the Fundamental Gneiss and the Grenville Series are largely represented, the latter running in wide and persistent bands across the country and consisting of micaceous gneisses and schists, quartzites, crystalline limestone, etc., often holding graphite. Great anorthosite intrusions cut these rocks, and from certain of these intrusions is derived the precious labradorite.

The Huronian is represented by several widely separated areas of clastic and volcanic rocks, together with many basic eruptives. They consist of schists of various kinds, with conglomerates, breccias, diorites and other rocks. The Laurentian and Huronian are intensely folded, the folding having taken place at a time long prior to the deposition of the sedimentary beds of Cambrian Age, and a sufficiently long time had elapsed, as has been mentioned, between the period of folding and the Cambrian submergence to permit of enormous denudation and erosion.

The Cambrian strata, which rest uncomformably upon the Laurentian and Huronian, consist of bedded sandstones, argillites, shales and limestones, along with bedded traps and other volcanic rocks and enormous deposits of excellent iron ore, whose mode of occurrence is closely analogous to that of the iron ores of Michigan and Wisconsin.

The surface of the country is mantled with drift, and there is distinct evidence that the whole Labrador peninsula, except a narrow strip of very high land along the North Atlantic coast, was completely buried in ice during a portion at least of the glacial period. The movement of the ice was outward in all directions from a central gathering ground. The position of this névé field was about midway between the east and west coast of the peninsula and between latitudes 53° and 55°, and the area is now characterized by the presence of partially rounded boulders and angular blocks of rock scattered over hill and hollow. Most of these repose on rocks of the same petrographical character as themselves and have evidently been transported but very short distances from their original positions. They probably represent boulders of decomposition but slightly modified by subsequent ice action.

The various sorts of drift and the forms assumed by the drift are described, although a detailed study of these was impossible, owing to the dense forest growth which covers the greater part of the area. There is distinct evidence of a past glacial uplift, which, however, it is believed was not equal all around the coast,

being about three times as great on the south and west margins as along the north and east coast, where two hundred feet appear to be the limit of raised marine terraces and beaches. Appended to the report are lists of the mammalia, birds, food fishes and plants found in Labrador, as well as an appendix by Mr. Ferrier on the microscopical structure of some of the rocks collected, and one by Mr. Eaton on the meteorology of the peninsula.

FRANK D. ADAMS.

McGILL UNIVERSITY, MONTREAL.

L' Evolution de commerce dans les diverses races humaines. Par CH. LETOURNEAU, Professeur à L' École d' Anthropologie. Paris, Vigot Freres. 1897. Pp. 581.

Professor Letourneau has made it his special branch to write about the development of arts and institutions. In the volume before us he takes up commerce, and aims to show its beginning and its growth in the various races and nations of humanity. Beginning with animals of lower species he is obliged to acknowledge that he finds no traces of commerce among them, and tells but one doubtful story of the possible interchange of values between a bird and a man.

In the lower races he discovers still little which is really commerce. When they give in exchange they appear to think each party makes a true gift to the other, and the mercantile idea is not present. Perhaps here he overlooks a peculiarity of human nature which exists in the highest as well as the lowest civilization. There is, for instance, a sort of pride which while expecting exchange on equal terms declines to recognize it as such. It is illustrated in the American custom of 'treating.'

Leaving this aside, the author pursues his investigations among the negro races of Papua and Africa, discovering in them a strong commercial instinct. In Polynesia he recognizes a widespread commerce, but his chapter on that of Ancient America is very much short of what the reader has a right to expect. The authorities whom he quotes are mostly second-hand, such as Prescott and Bancroft, and he does not seem to be acquainted with the valuable articles of Professor Rau on this topic. Hence we are not surprised to find on page 173 the assertion that the Indians considered commerce of the least possible importance; whereas, every one acquainted with the facts knows that it was one of their most active avocations.

He is more at home when dealing with the early commerce of China, Japan, Egypt and the Arabs, who next occupy his attention. Of their activity in this direction he presents a well written sketch. The classical epochs of Greece and Rome are described in their commercial relations, and from them he passes on to mediæval and modern life, of which he gives a hasty outline. His final chapter is intended to embrace the survey of his results and the forecast of what commerce may be in the future. In this prophetic utterance he indulges in some of those dreams of a possible future society with which he delights to amuse his readers, but for which he acknowledges his hopes are faint.

The work is well printed and has a carefully arranged table of contents and a sufficient index.

D. G. BRINTON.

How to Know the Shore Birds (Limicolæ) of North America. By CHARLES B. CORY. Boston, Little, Brown & Co. 1897. Small 4to. Pp. 89. Price in paper, 75 cents.

How to Know the Ducks, Geese and Swans of North America. By the same author and publisher. Pp. 95. Price in paper, $1.00.

These publications are a departure in the way of ornithological literature. Each consists of a key, with figures of heads, bills and tails, followed by plain descriptions of the species, with additional illustrations and a paragraph or two on the range and eggs. The illustrations are half-tone reproductions of wash drawings by Edward Knobel, and while not equal in artistic merit to those of Fuertes, Ridgway or Thompson are excellent for purposes of identification, and some are admirable as pictures, particularly the one of a group of Labrador ducks. In the case of the shore birds, where the beginner is often confused by strikingly different seasonal plumages, both summer and winter dress are shown; and in the case of the water birds having different sexual plumages, pictures of both male and female are given.

The keys do not conform to the modern

'dichotamous' system, now so generally and so deservedly popular. They are based primarily on length of wing, and there are usually several successive categories of equal rank. The objections to this arrangement are partly overcome by the use of very large type for the main headings.

The books are intended primarily for sportsmen and others "who are interested in birds and would like to know their names, but often find it no easy task to identify them by the 'bird books.'" That they fulfill this purpose admirably will be evident to all who use them. The paper and press work are good and the prices remarkably low.

Mr. Cory has made many contributions to ornithology, the most important of which relate to the 'Birds of the West Indies.' His entertaining 'Hunting and Fishing in Florida,' published about a year ago, gained him a wider circle of readers, but it is doubtful if any of his writings will prove so helpful to so large a class as the two that form the subject of this review.

C.H. M.

Les gaz de l'atmosphère. Par H. HENRIET. Paris, Gauthier-Villars et Fils; Masson et Cie.

This short treatise presents the reader in concise form a great deal of useful information with regard to the composition, methods of analysis, and rôle played by the various constituents, of the atmosphere. While the references to recent work would seem to indicate that the book is abreast of the times, the fact that, with few exceptions, the investigations noted are those by French scientists only is not calculated to inspire confidence in the author's conclusions. In the text, although the names of others than Frenchmen occasionally appear, there is no reference to any paper not printed in a French journal. In a bibliography whose length should guarantee its completeness, there is the title of one English book and that of one Italian memoir; the remainder are all French. On the other hand, as the book is evidently written for Frenchmen, it may be that the author gave only such references as would be readily available in almost any public library in France. On the whole, this defect will militate against the use of M. Henriet's convenient little book by others than his fellow-countrymen.

W. W. R.

Argon, a New Constituent of the Atmosphere. By LORD RAYLEIGH and PROFESSOR WILLIAM RAMSAY. Washington, The Smithsonian Institution. 1896.

This paper is published by the Smithsonian Institution in the form in which it was presented in competition for one of the Hodgkins Fund prizes. It remains but to notice that it differs from the abstract which appeared in the *Proceedings of the Royal Society*,* in that it contains detailed accounts of experiments and results omitted in many cases from the abstract; and from the fuller paper in the *Transactions*,† since the latter incorporates the results of later experiments in several directions.

It may be as well to call attention to a typographical error in the formula (p. 35) which indicates the relation between the velocity of sound in a gas and the ratio of the specific heats: 'N' should be '$\sqrt{\ }$.' W. W. R.

Atmospheric Actinometry and the Actinic Constitution of the Atmosphere. By E. DUCLAUX. Washington, The Smithsonian Institution. 1896.

This paper is a translation of that presented by M. Duclaux in competition for one of the Hodgkins Fund prizes. It represents an endeavor to measure the quantity and effect of the actinic solar rays, as distinguished from the luminous and calorific, under varying atmospheric and climatic conditions.

The reagent employed for these measurements is a solution of oxalic acid; this is rapidly oxidized by actinic rays, is not affected by the luminous rays and scarcely at all by the calorific, while the reaction is but slightly exothermic. From the summary of results the following may be noted as of special interest: The 'daily combustion' varies from one day to another much more than any other meteorological phenomenon. It shows the influence of the seasons and manifestly exhibits a maximum in the

* Vol. 57, p. 265. This paper also was published in this country, *e. g.*, *American Chemical Journal*, Vol. 17, p. 225.

† Vol. 186, p. 187.

spring. It is but feebly subject to the influence of altitude. So sensitive is it to the presence of oxidizable substances in the air that daily and local variations must be due to the existence in the atmosphere of 'actinic clouds' otherwise undiscoverable. In northern latitudes the atmosphere is less absorbent of actinic rays and hence that kind of radiation is more active relatively than in lower latitudes. The actinic effect of the sun increases more rapidly than the duration of its presence above the horizon; as a result, the effect produced during the long days of the northern summer is proportionally very great. The actinic effect may continue after the luminous effect of the sun's radiation has become clouded; thus the effect of a fine morning is not lost by a dark and cloudy evening. The duration of the day and the solar effect as usually measured are of little value for calculating the true actinic effect of sunlight. The paper as a whole is of unusual interest.

W. W. R.

SOCIETIES AND ACADEMIES.

KANSAS ACADEMY OF SCIENCE.

THE thirteenth annual meeting of the Academy was held at Baker University on October 27th, 28th and 29th, under the presidency of Professor S. W. Williston.

The scientific program was as follows:

The migrations of birds..........................J. R. Mead
A list of the Goss Ornithological Collection, being the report of the Board of Curators....D. E. Lantz
A Bibliography of Kansas ornithology, with an historical list of Kansas Birds...........D. E. Lantz
A list of the birds taken in Mexico and Central America by the late Colonel N. S. Goss, with notes of localities...........................D. E. Lantz
An historical list of Kansas mammals.......D. E. Lantz
The injurious insects of the year in Kansas......... S. J. Hunter
Kansas *Lachnosterna*.........................Warren Knaus
Entomological collecting notes...........Warren Knaus
Observations on the elm-twig girdler................ Percy J. Parrott
The natural history possibilities of Belvidere, Kansas...C. N. Gould
An inexpensive dissecting-stand for microscopical dissections...................................S. J. Hunter
Biological notes.................................S. J. Hunter
A floral horologue for Kansas...............B. B. Smyth
Root tubercles and their production by inoculation..D. H. Otis
Therapeutical notes on some Kansas plants......... L. E. Sayre
Notes on Kansas plants...................A. S. Hitchcock
Bibliography of literature relating to wind effects on trees...................................J. B. S. Norton
On the finding of insects in the Comanche Cretaceous of Kansas.............................C. N. Gould
Fusulina cylindrica shell structure........Alva J. Smith
Range and distribution of the *Mosasauria*........... S. W. Williston
A new *Labyrinthodont* from the Kansas Carboniferous..S. W. Williston
Geological notes on Trego County and vicinity J. W. Beede
A preliminary report on the geology of the Delaware Valley in Atchison County.....J. W. Wilson
New developments in the Mentor beds...C. N. Gould
Extremes and means of Kansas climate....F. H. Snow
Viscosity of the ether...................A. St. C. Dunstan
Alternating currents in a Wheatstone bridge where branches contain resistance and capacities...Martin E. Rice
Equilibrium of forces in a flim originally spherical, grounded in the presence of an external electric charge...............................L. I. Blake
Some problems of marine telephony without wires..L. I. Blake
The dehydration of gypsite...............E. H. S. Bailey
Some new mineral waters................E. H. S. Bailey
Decomposition of some diazo compounds with methyl alcohol...........................Geo. F. Weida
On the generation of finite transformations from infinitesmal transformations..........H. B. Newson
Additional notes on the timbered mounds of the Kaw Reservation...........................C. N. Gould
Relativity in science............................E. B. Knerr

The subject of the President's address was 'Science and Education.'

NEW BOOKS.

Allgemeine Erdkunde. I. HANN, ED. BRÜCKNER and A. KIRCHOFF. II. part, fifth edition. Prag, Wien and Leipzig, F. Tempsky. 1898. Pp. xii+368. M. 8.

Das kleine botanische Practicum für Anfänger. EDWARD STRASBURGER. Third edition. Jena, Gustav Fischer. 1897. Pp. viii+246. M. 6.

Nature Study in Elementary Schools. MRS. L. L. WILSON. New York and London, The Macmillan Co. 1897. Pp. xix+262.